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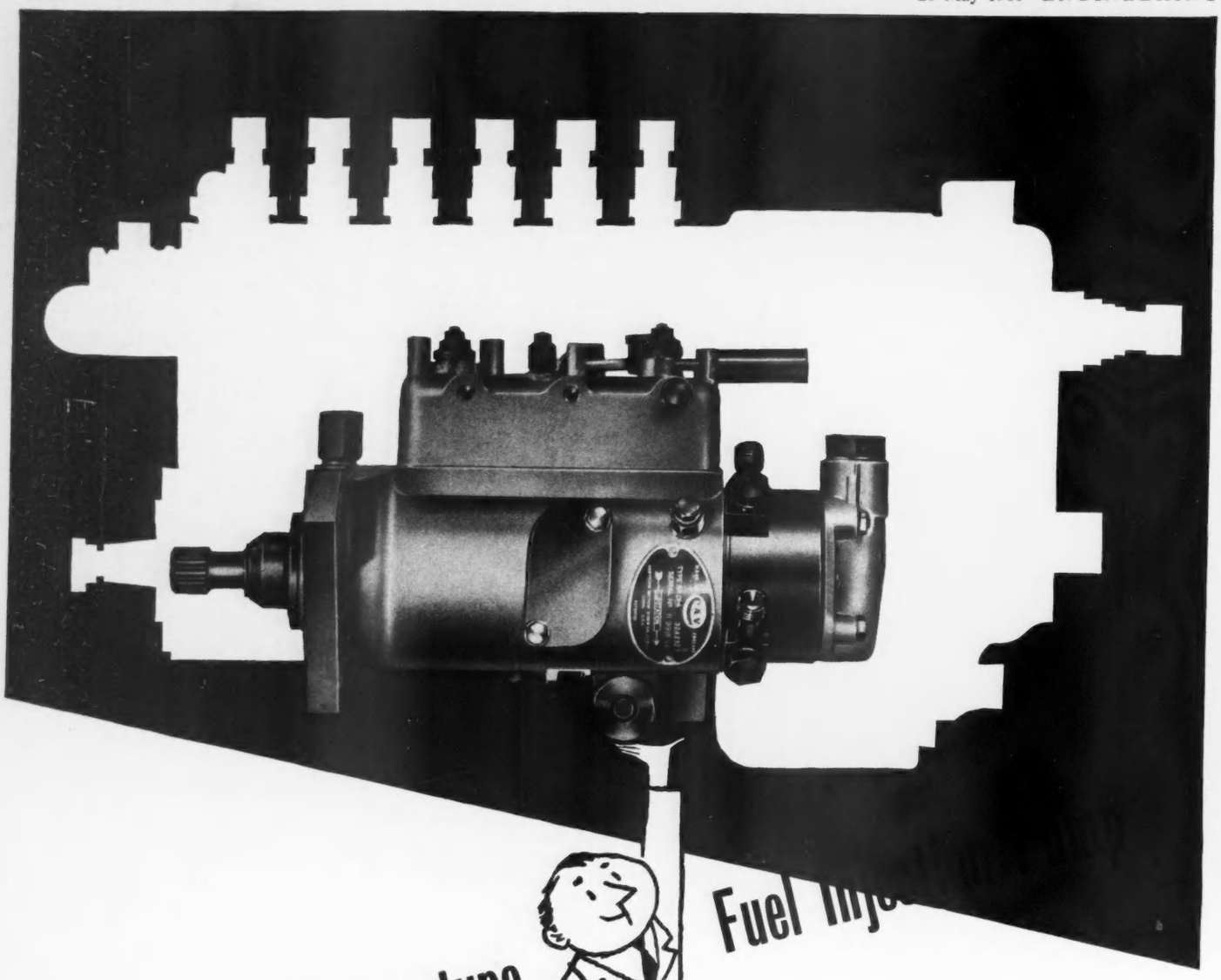

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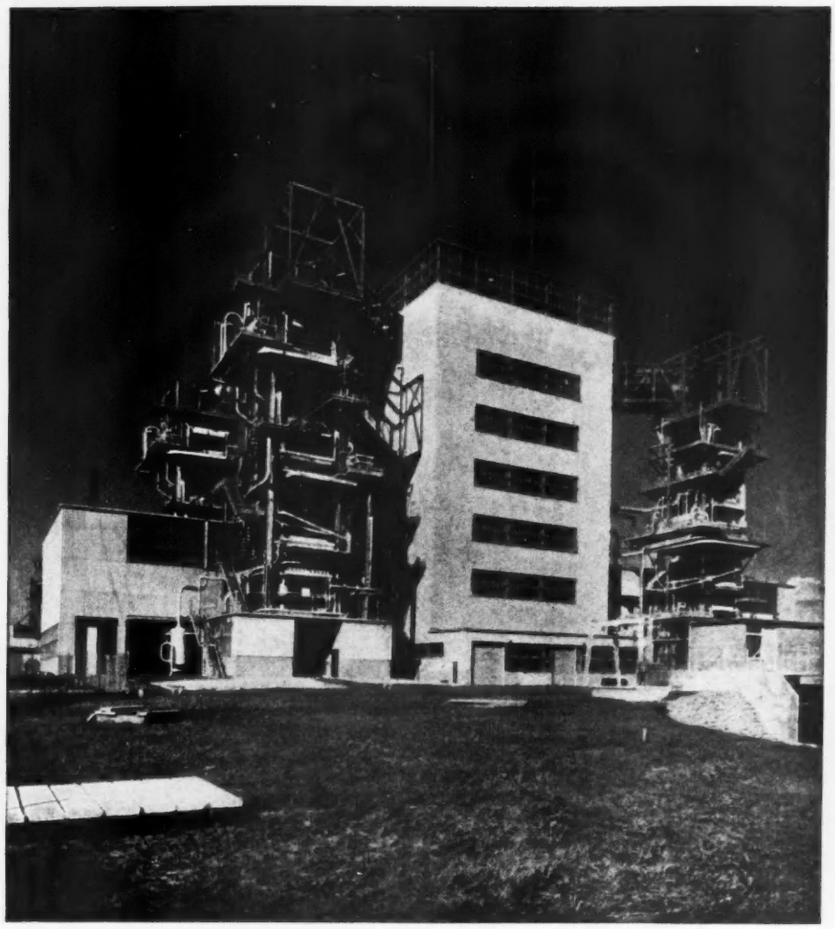

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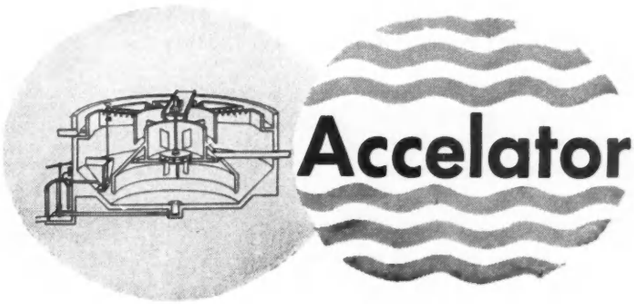

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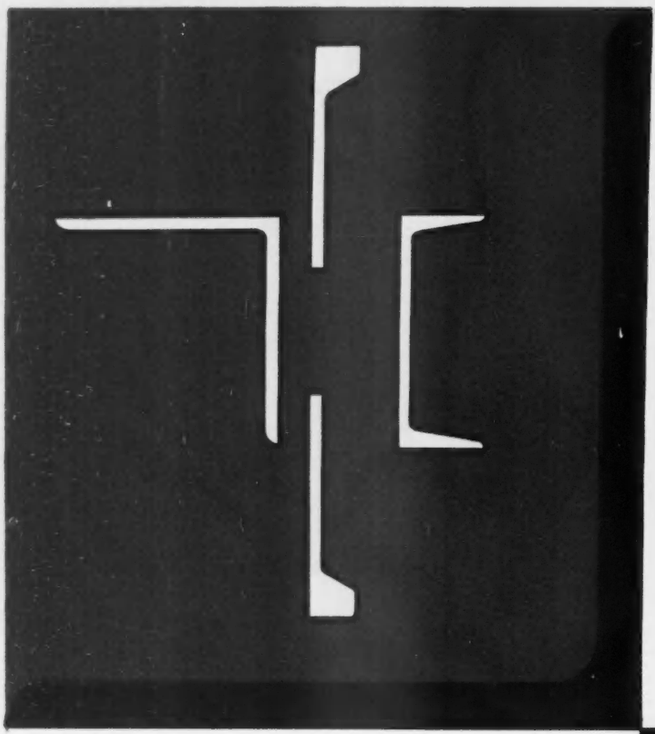

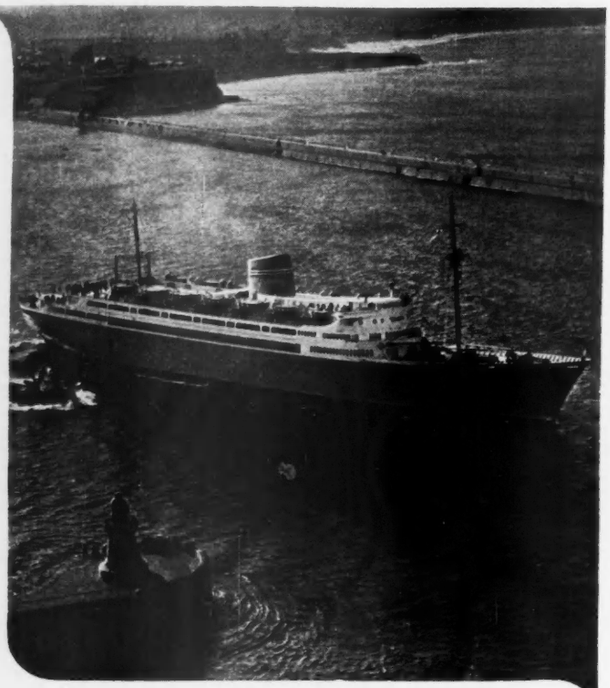

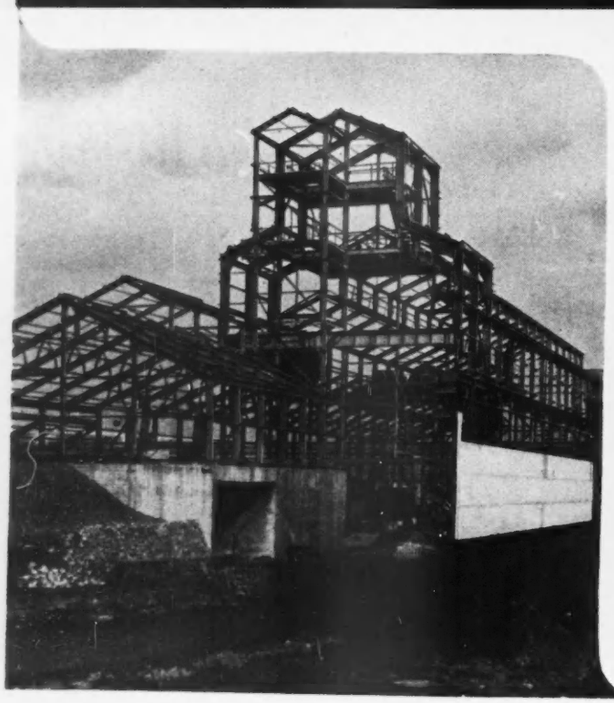

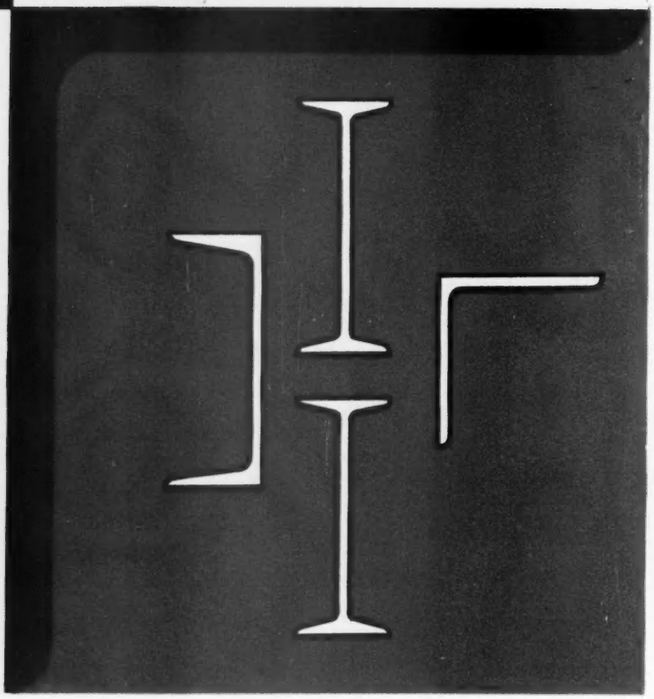

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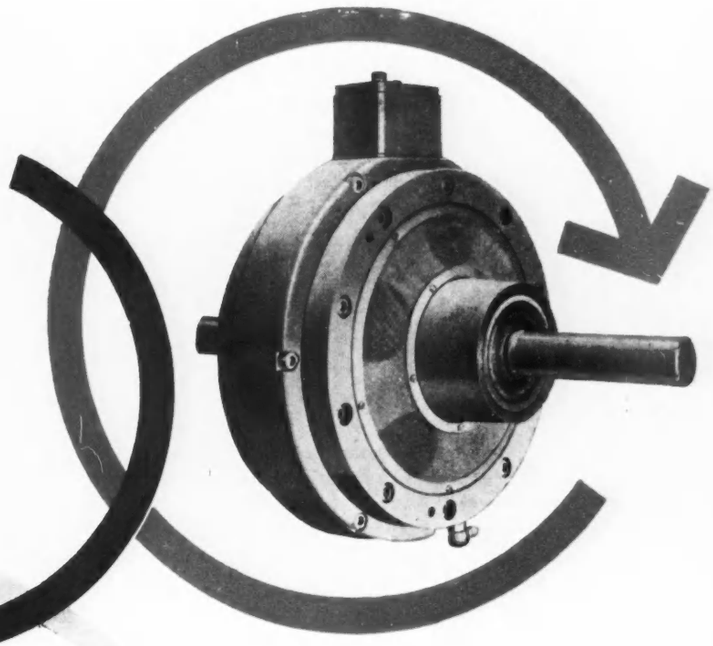

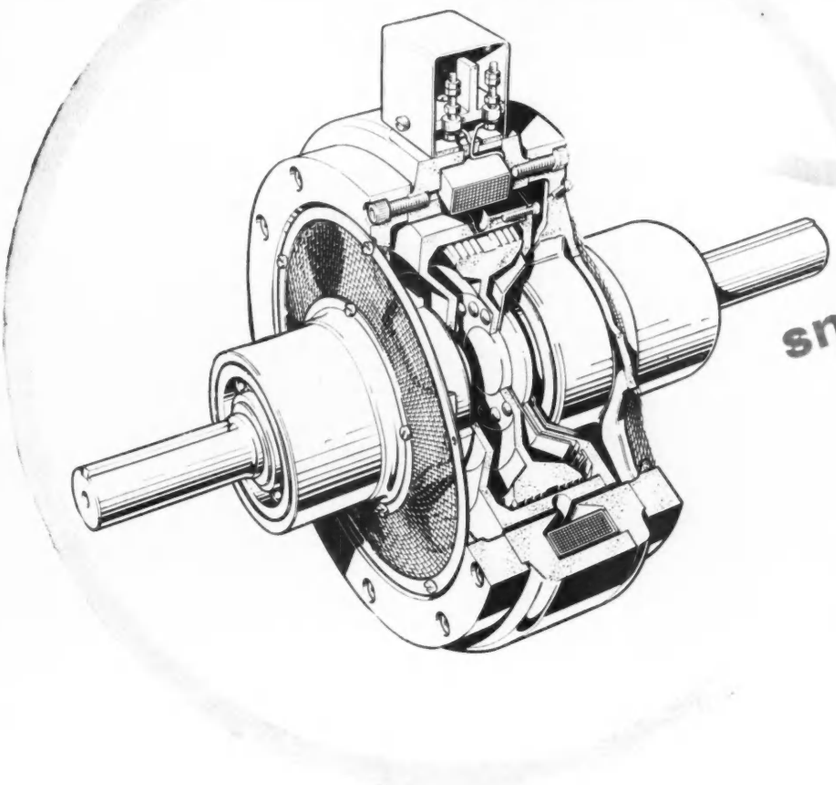

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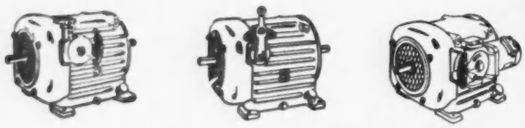

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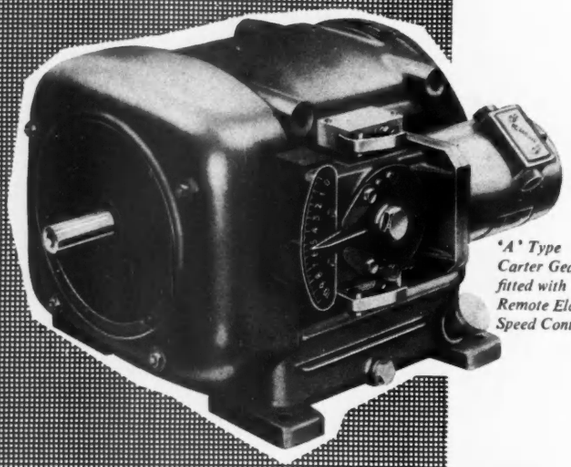

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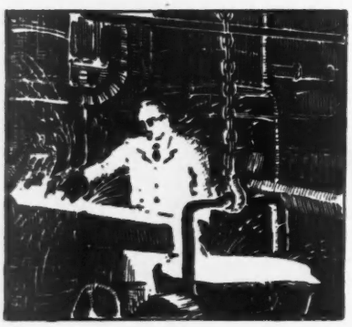

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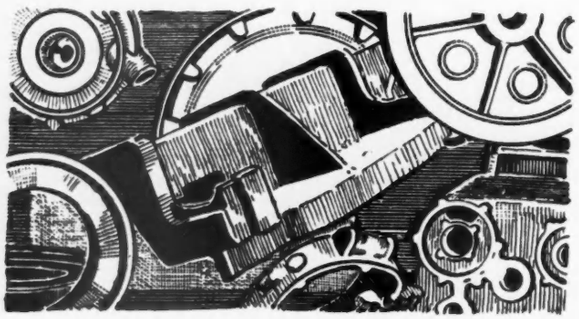

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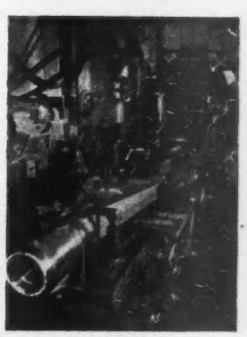

Cover Picture

Utilising the die sinking attachments of a hydraulic copying milling machine on a main leg forging for the Argosy. At the far end of the machine a mahogany pattern controls the operation. (*Nurnberg photograph for* ENGINEERING.)

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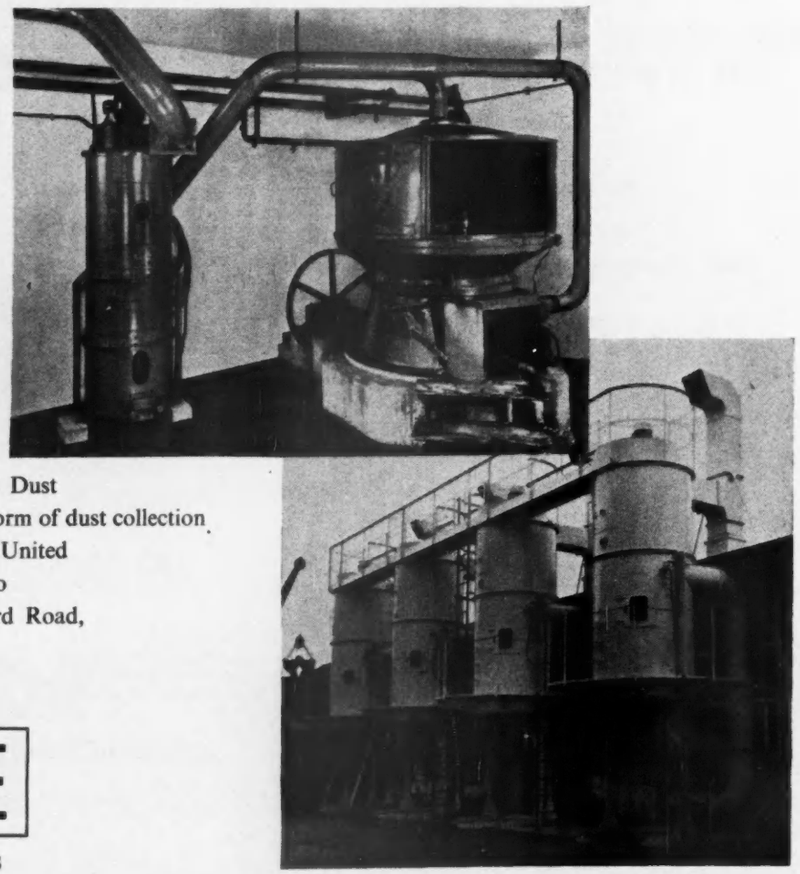

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Application forms and details for both courses can be obtained from:

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TENDERS (FORMS FROM CHIEF EDUCATION OFFICER, 3 CAUNCE STREET, BLACKPOOL), returnable by 2.30 P.M., 27th MAY, 1960, invited for the supply of ENGINEERING EQUIPMENT (ADVANCED MACHINE SHOP, MECHANICAL, AND THERMODYNAMICS) for the Blackpool Technical College and School of Art. C 64

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Each Tender must be enclosed in a sealed envelope marked "Confidential—Tender for supply of Low Voltage Switchboards," and must be received at the Office of The Secretary, Electricity Corporation of Nigeria, Electricity Headquarters, Private Mail Bag 2030, Lagos, Nigeria, West Africa, not later than noon on 22nd June, 1960. Tenders received in any other manner will not be considered.

The Electricity Corporation of Nigeria does not undertake to accept the lowest or any tender.

Further information concerning this Contract may be obtained on application to the RESIDENT ENGINEER.

GEORGE W. NICOL,
ACTING SECRETARY TO THE CORPORATION. C 79

THE OFFICE OF THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDINGS, BROMYARD AVENUE, ACTON, W.3, invites **TENDERS** for the following:—

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(b) **"MULTISPINDLE DRILLING MACHINES,** viz., 12 Spindle M/c., 2 (Nos.); 18 Spindle M/c., 2 (Nos.).

(c) **"UNIVERSAL THREAD GRINDING MACHINE.**
Max. length between centres ... 20 in.
Max. dia. of work ... ... 10 in.
Similar to Matrix No. 39.

(d) **"UNIVERSAL THREAD GRINDER.**
Max. length between centres 11 in. Max. dia. of work 2 in.
Similar to Matrix No. 16."

Specifications, etc., can be obtained from the COORDINATION BRANCH, INDIA STORE DEPARTMENT, GOVERNMENT BUILDINGS, BROMYARD AVENUE, ACTON, W.3, at a cost of TEN SHILLINGS per tender enquiry which is not refundable. Tenders are to be returned to the above address by MONDAY, 20th June, 1960. Specimen copy of the above enquiries can be seen at Engineering Branch, India Store Department, under the following references:—

(a) 2030/58/88B/ENG. 3.
(b) 2056/59/88B/ENG. 3
(c) 2058/59/88B/ENG. 3.
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THE OFFICE OF THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, invites **TENDERS** for the following:—

TENDER ENQUIRY NO. 2062/59/ENG. 2.
"For the supply of two numbers Electric Bogie Haulage Gear, 120 tons capacity, for forging furnace."

Specification, etc., can be obtained from the COORDINATION BRANCH, INDIA STORE DEPARTMENT, BROMYARD AVENUE, ACTON, W.3, at a cost of TEN SHILLINGS per Tender. The Tenders are due to be returned to INDIA STORE DEPARTMENT, at the above address, so as to reach them by 2 p.m. on MONDAY, 20th JUNE, 1960.

Specimen copy of the above specification can be seen at ENGINEERING BRANCH, INDIA STORE DEPARTMENT, ACTON, W.3, under the following reference, 2062/59/ENG. 2. C 93

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The Contract now advertised will comprise two horizontal type Francis waterwheels directly coupled to two 2,750 kilowatt 11 kV Alternators, inlet valves, lifting and handling equipment and ancillary equipment.

Tenders are invited only from firms who are prepared to submit complete tenders.

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At a later date offers will be invited for Transformers, Cables and Lighting. Persons interested in such should NOT now apply, but await further advertisements.

The Central Electricity Board do not bind themselves to accept the lowest or any Tender, nor will they be responsible for any costs incurred by Tenderers in making their Tender. C 70

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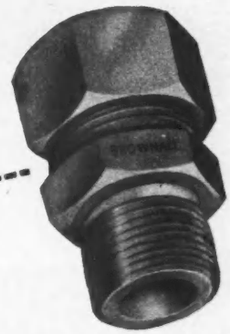

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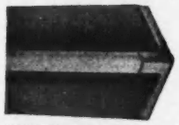

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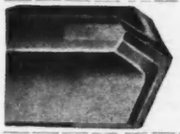

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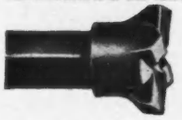

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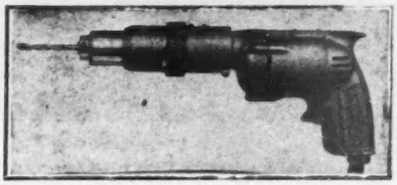

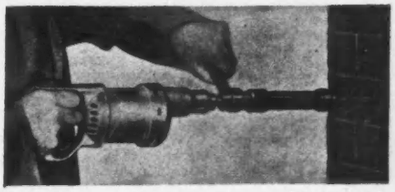

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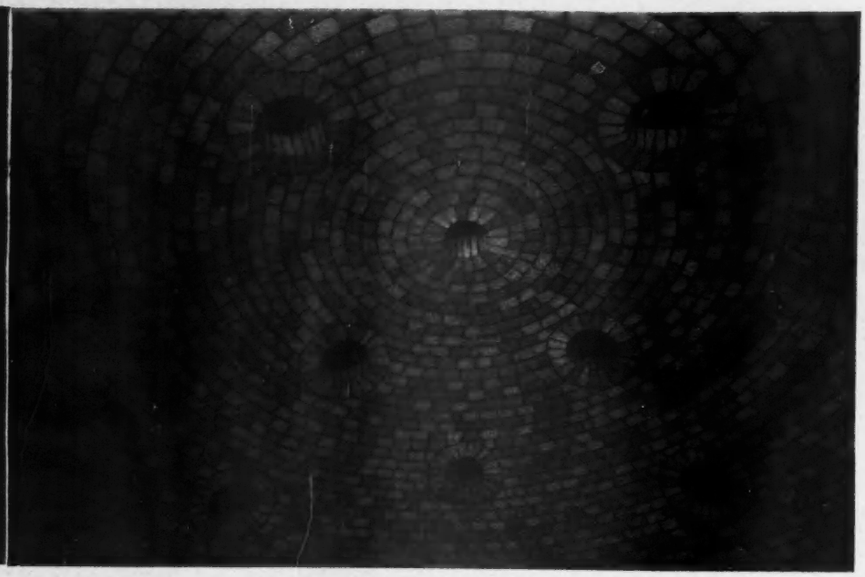

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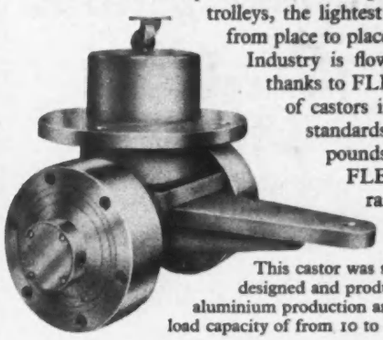

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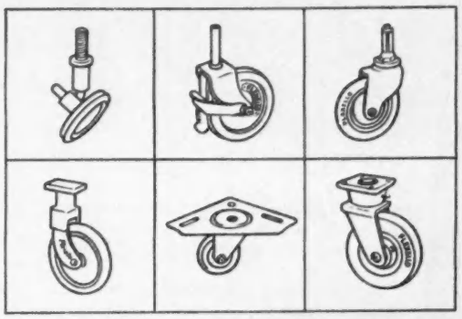

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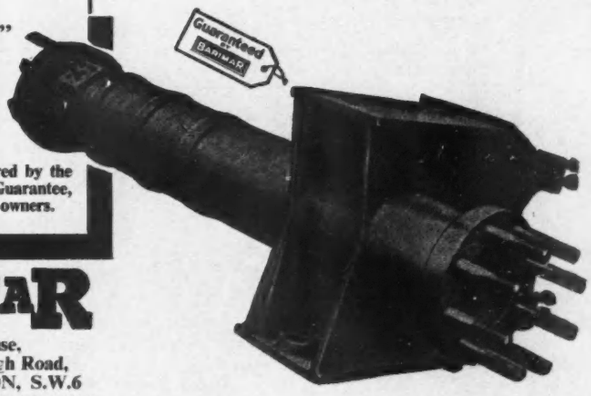

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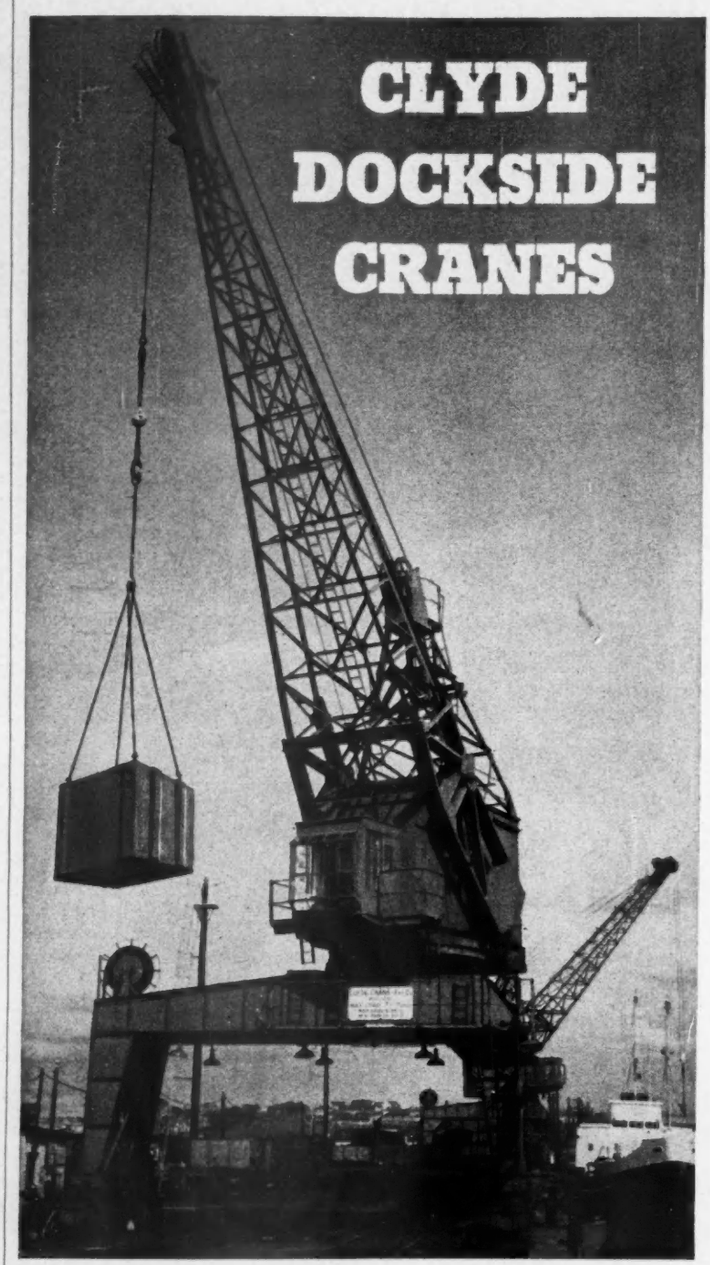

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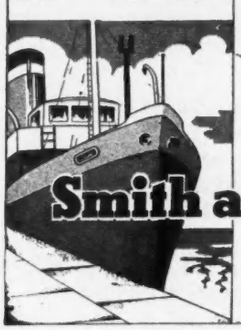

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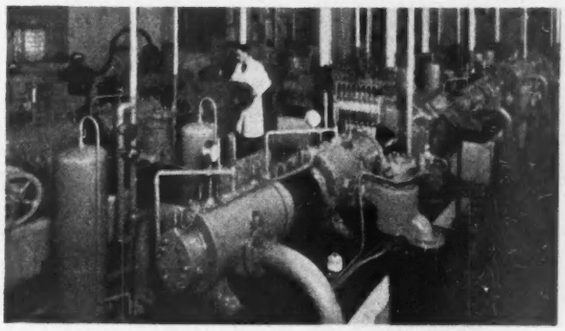

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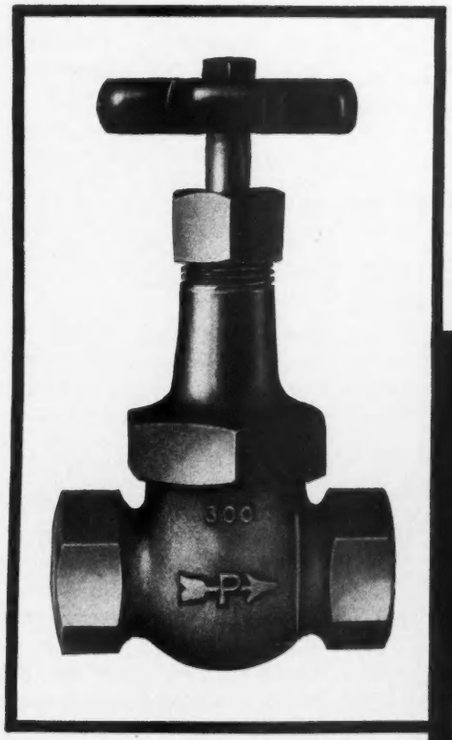

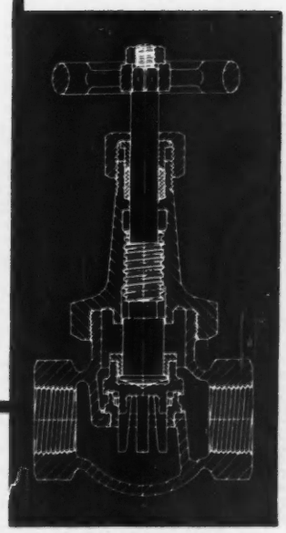

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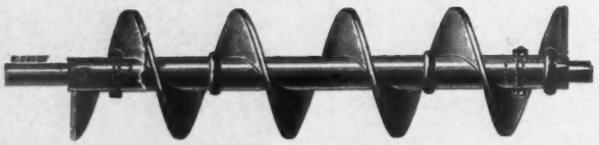

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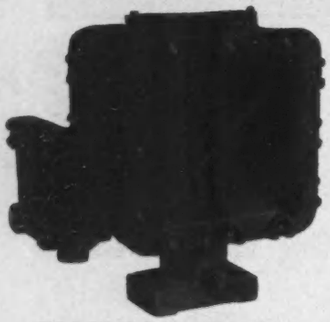

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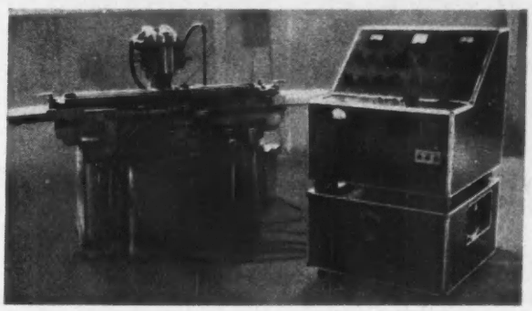

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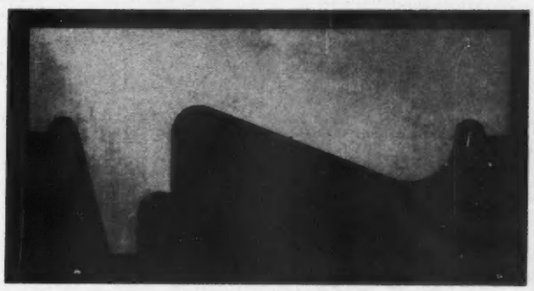

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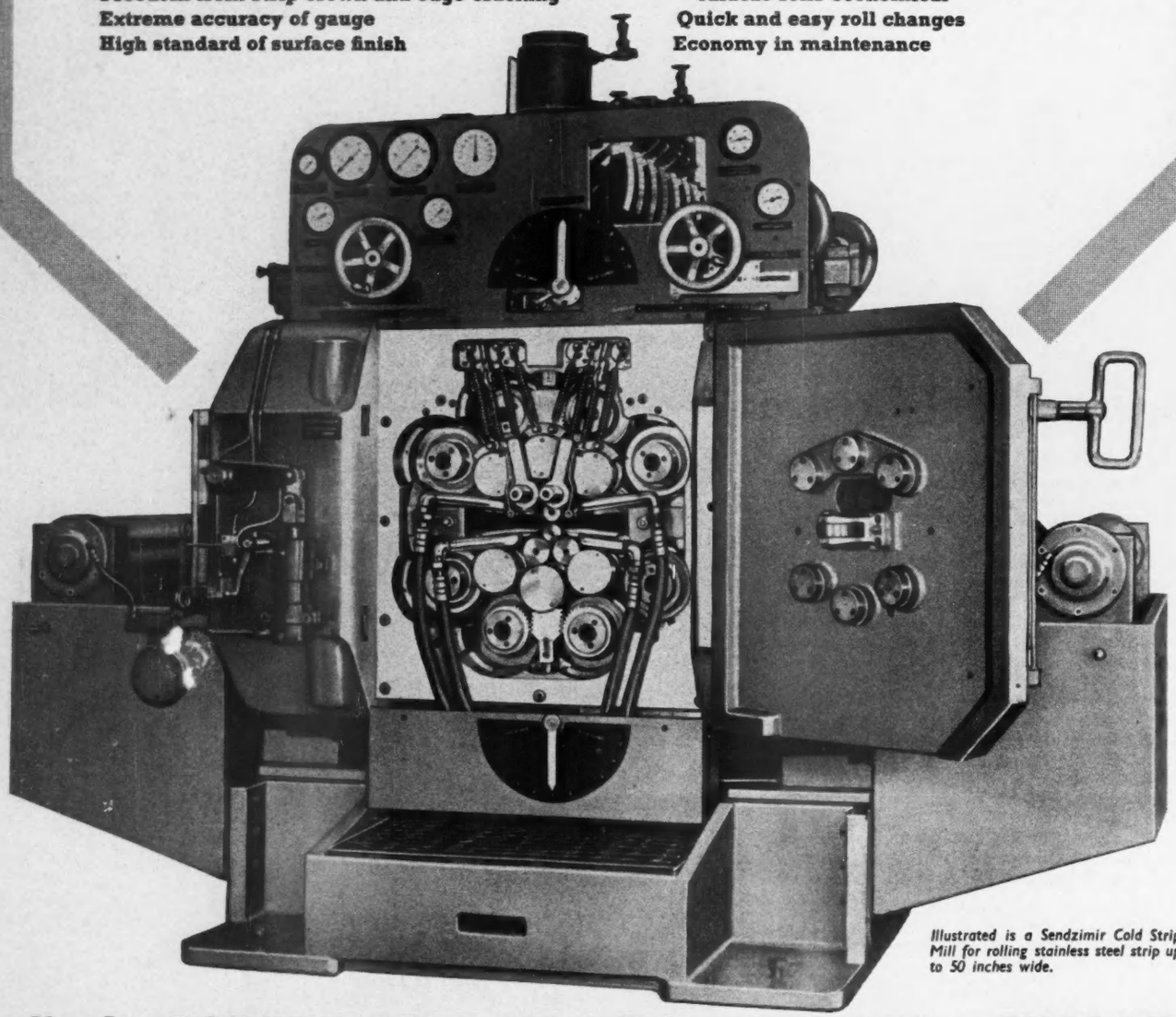

Illustrated is a Sendzimir Cold Strip Mill for rolling stainless steel strip up to 50 inches wide.

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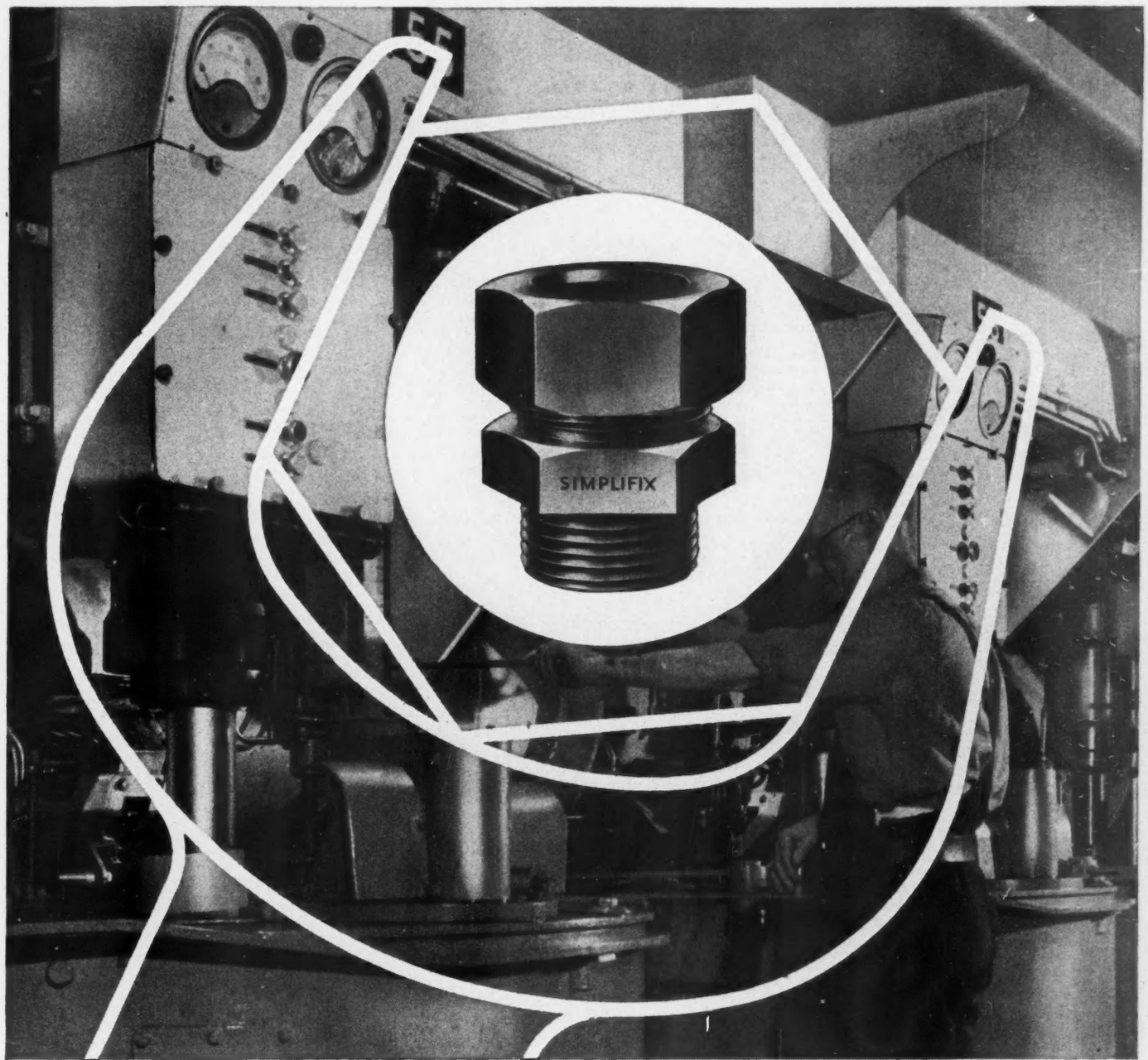

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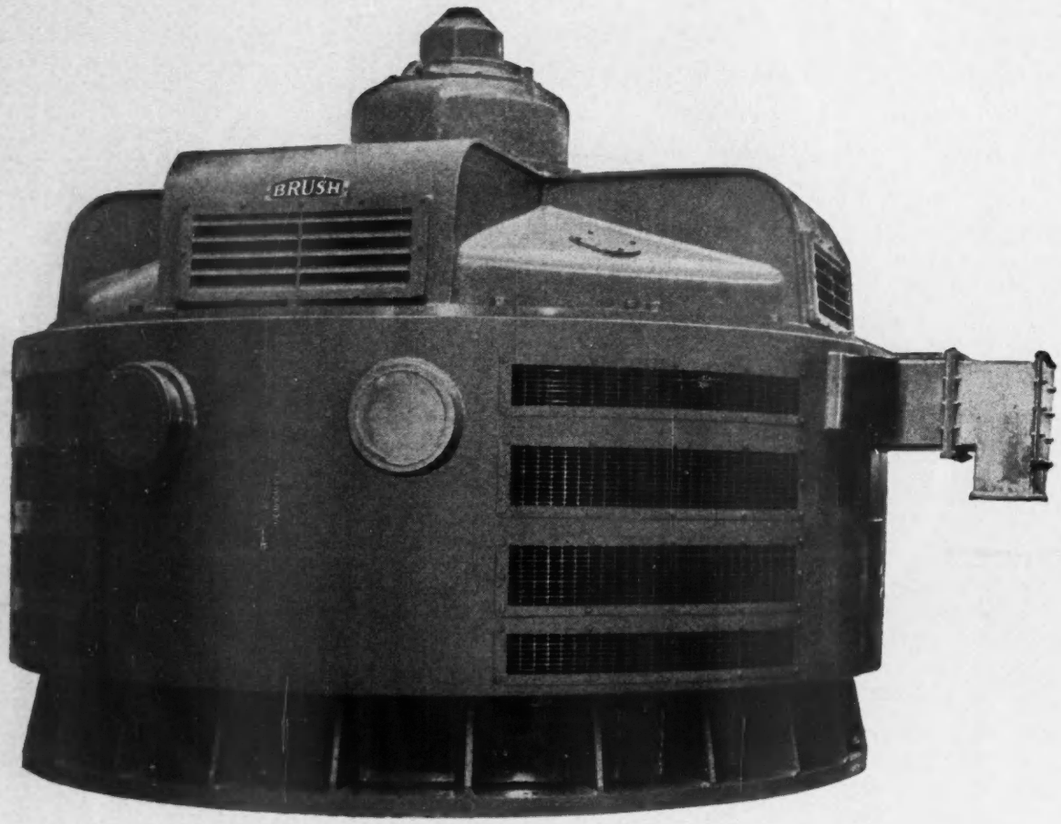

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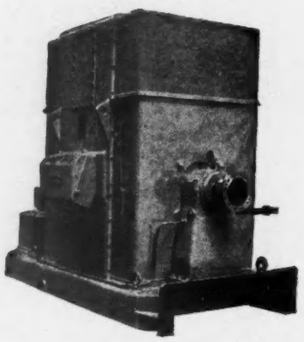

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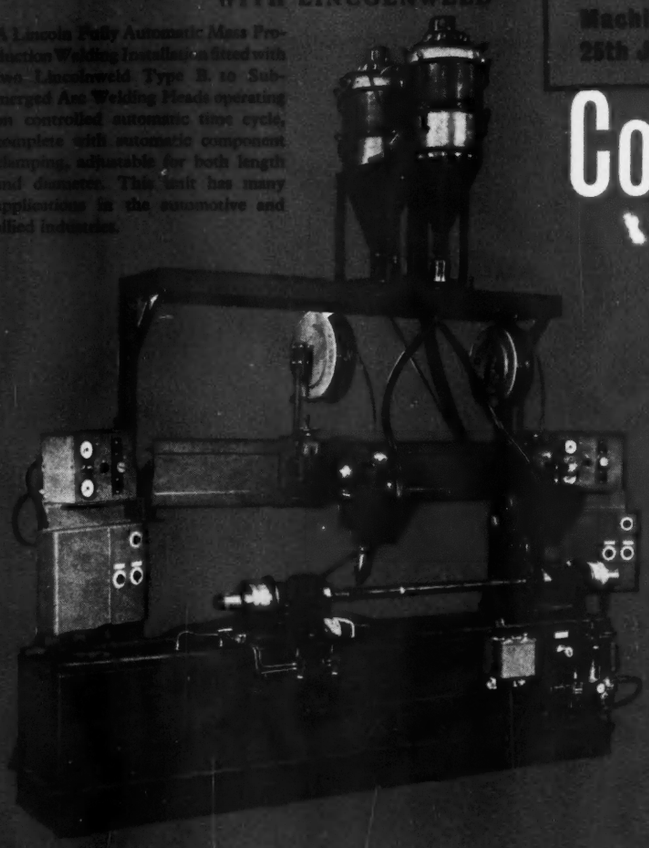

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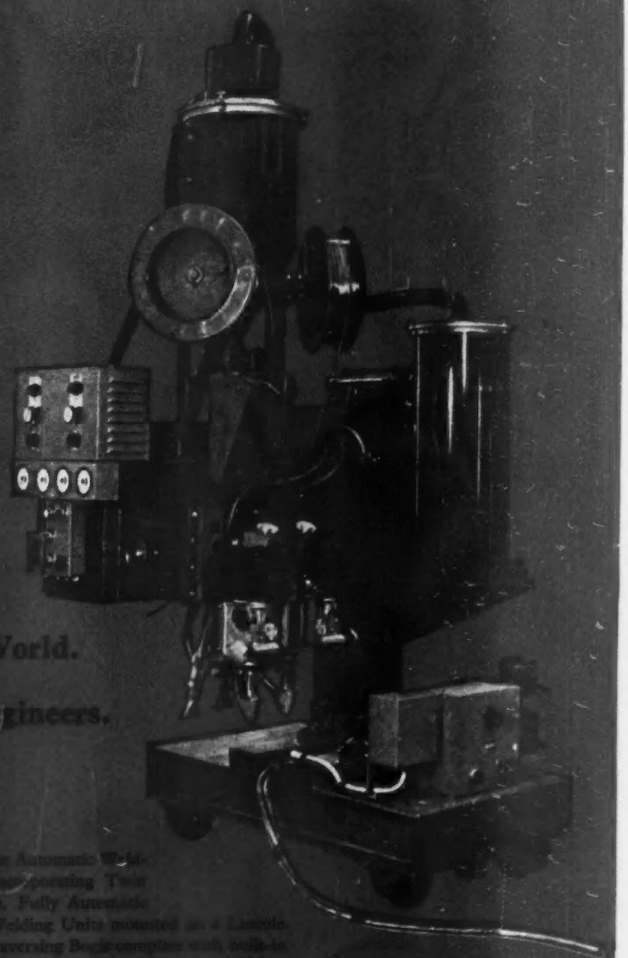

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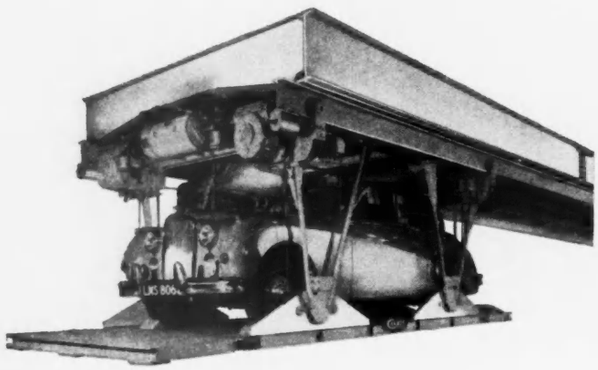

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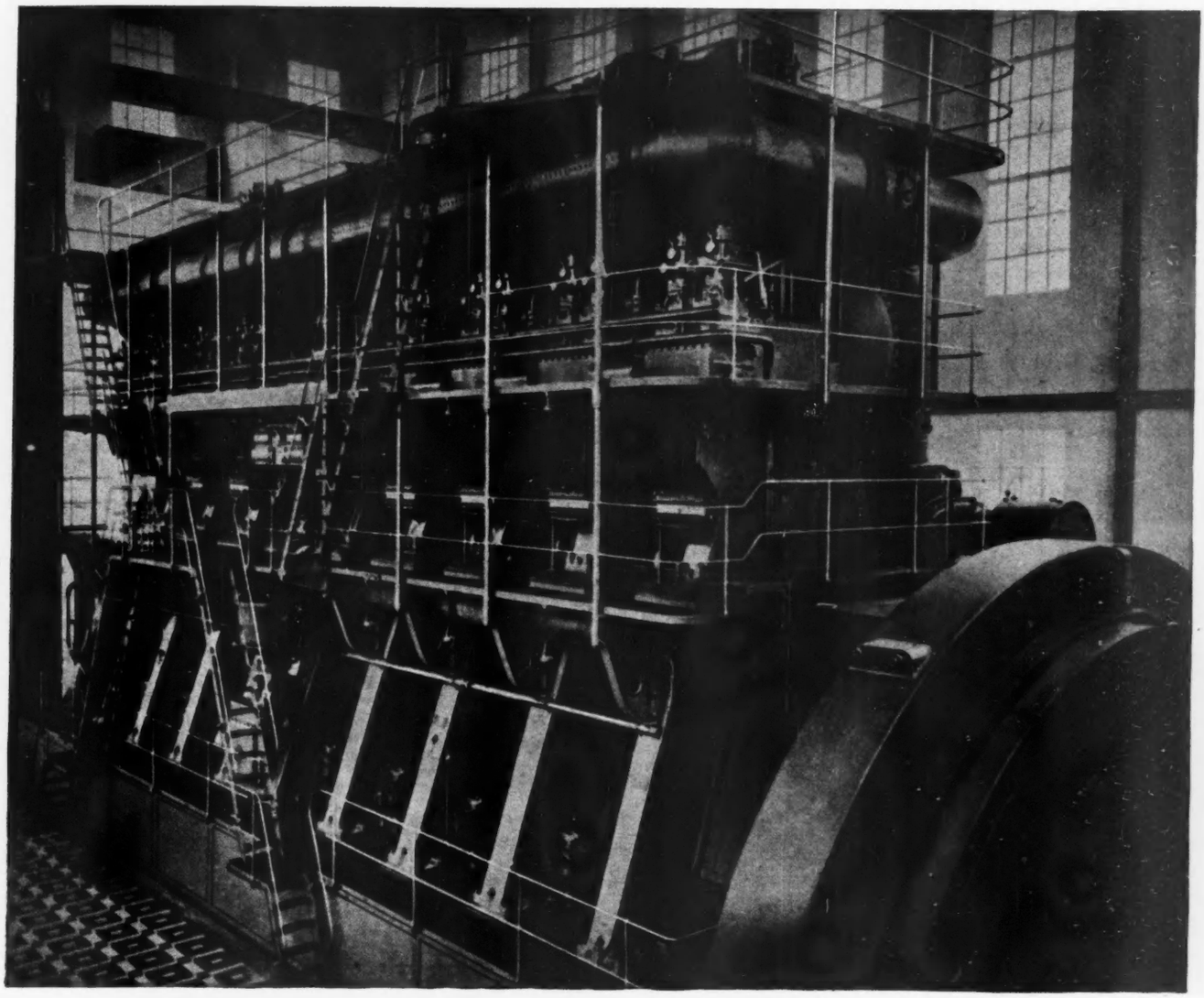

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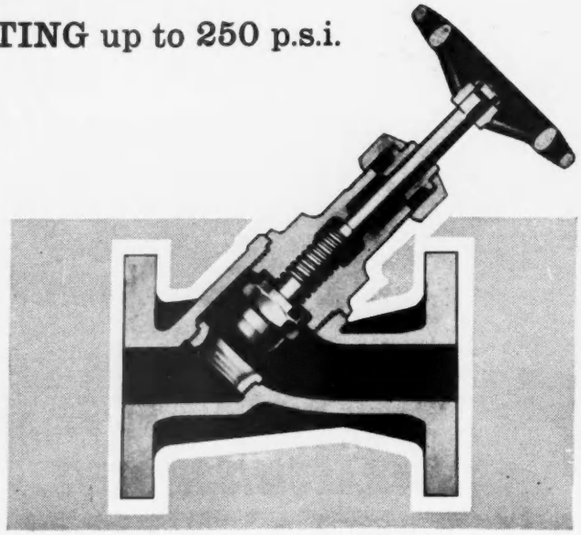

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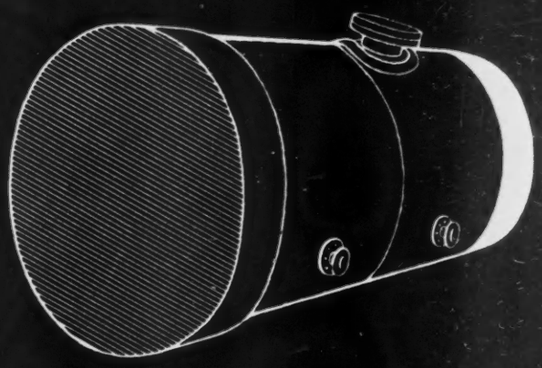

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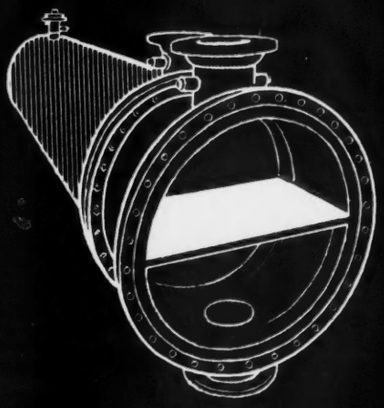

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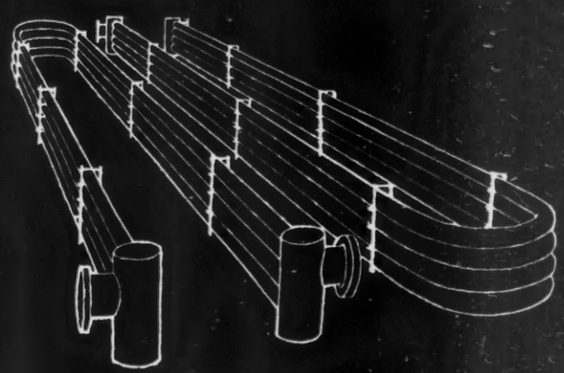

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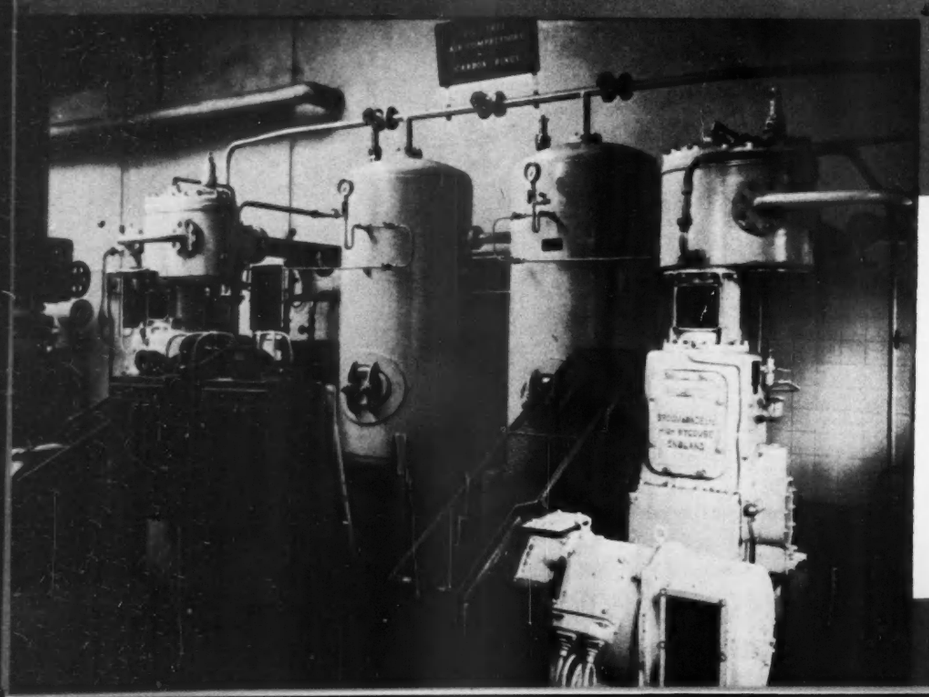

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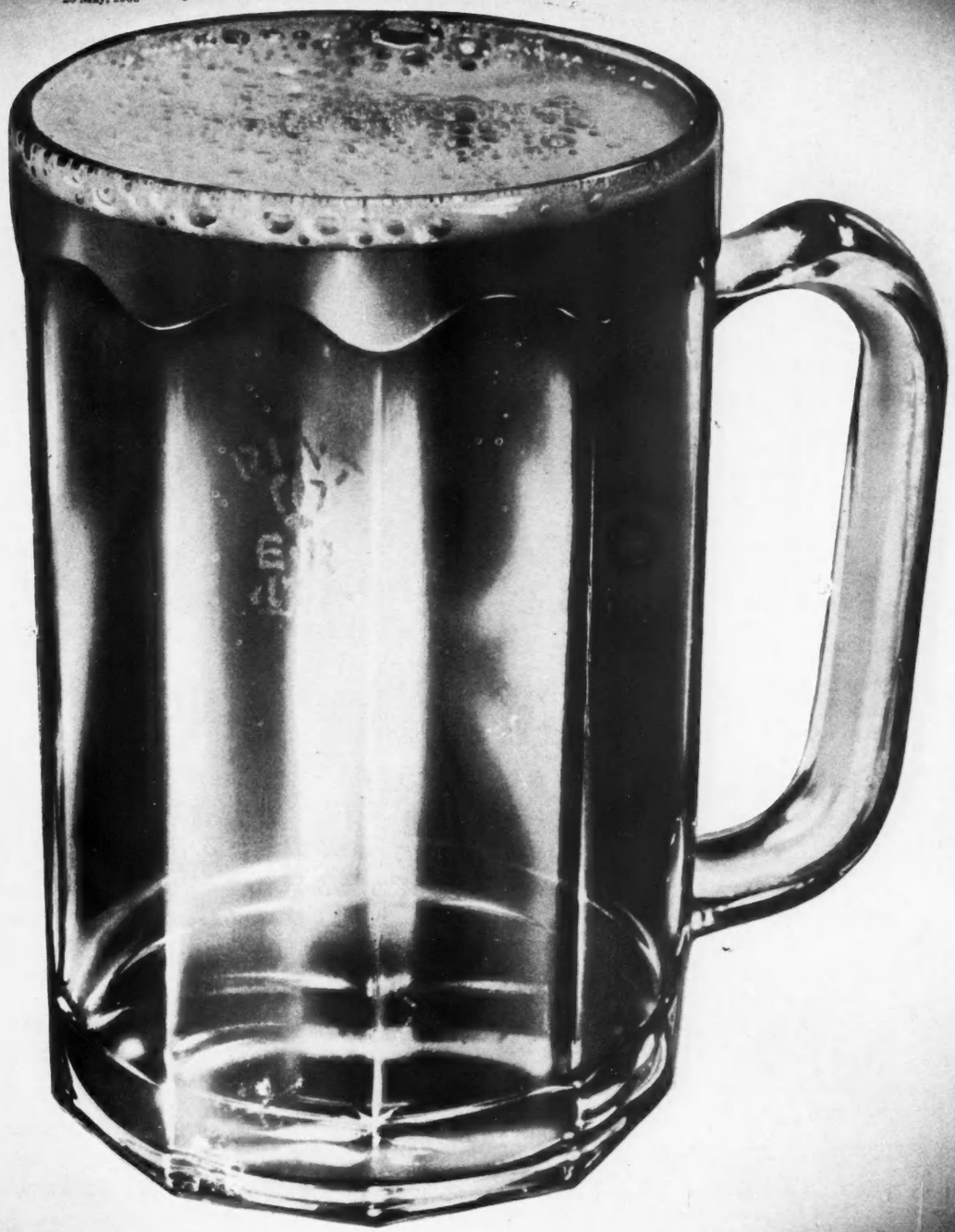
729 SAS



"BROOMWADE" TYPE C660 Dry Cylinder Carbon Ring Air Compressor delivering 100 c.f.m. of OIL-FREE AIR at 100 p.s.i.

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AIR COMPRESSORS & PNEUMATIC TOOLS

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CROFTS STATIONARY FIELD MAGNETIC INSTRUMENT CLUTCHES

Specially developed for use in the increasingly important fields of light engineering and instrumentation, they have a wide variety of applications as clutch couplings, clutch brakes and duplex clutches.

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Write for Publication 6013, *showing typical applications, and giving operating data, technical details, and dimenions.*

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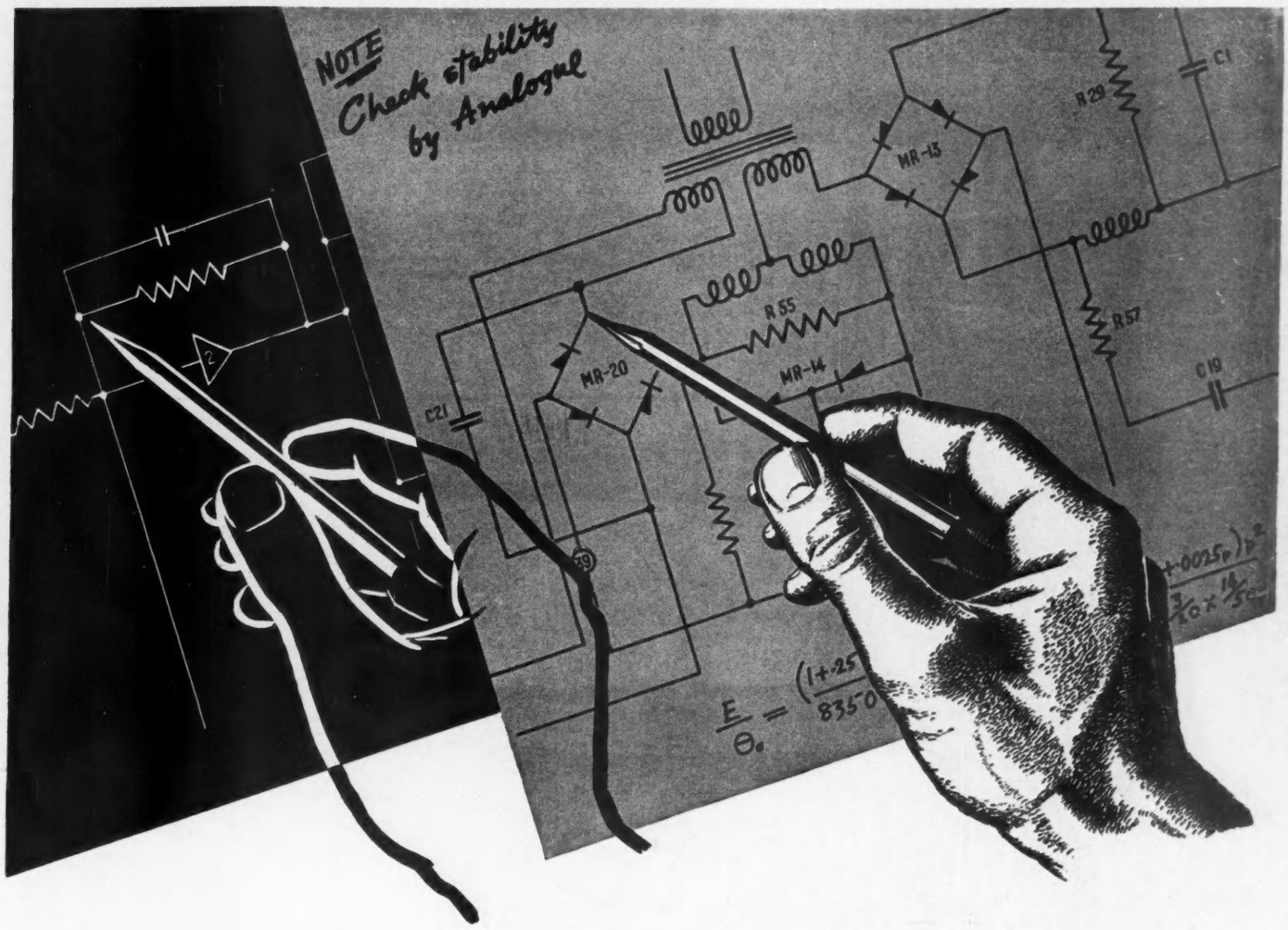

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The experience gained by this Company over many years of Control Engineering in almost every industry, together with considerable resources for research and development are available to you for the solution of your present and future control problems.

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control gear

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CG 1A

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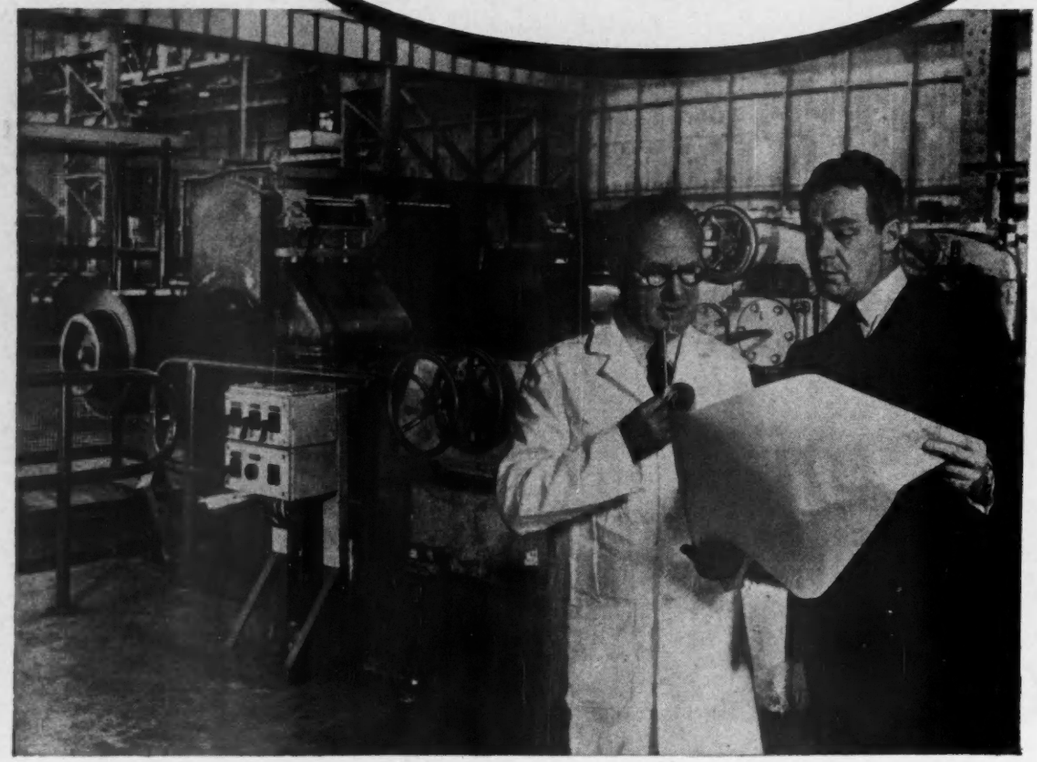
AEI engineers know the Steel Industry



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By working closely with the industry over many years they have virtually become a part of it. They study its problems closely, and are always at hand to advise on electric drives and control equipment. Call on them at any time. They will assist you with everyday plant problems or the planning of major projects.

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INCORPORATING THE MOTOR AND CONTROL GEAR INTERESTS OF BTH AND M-V

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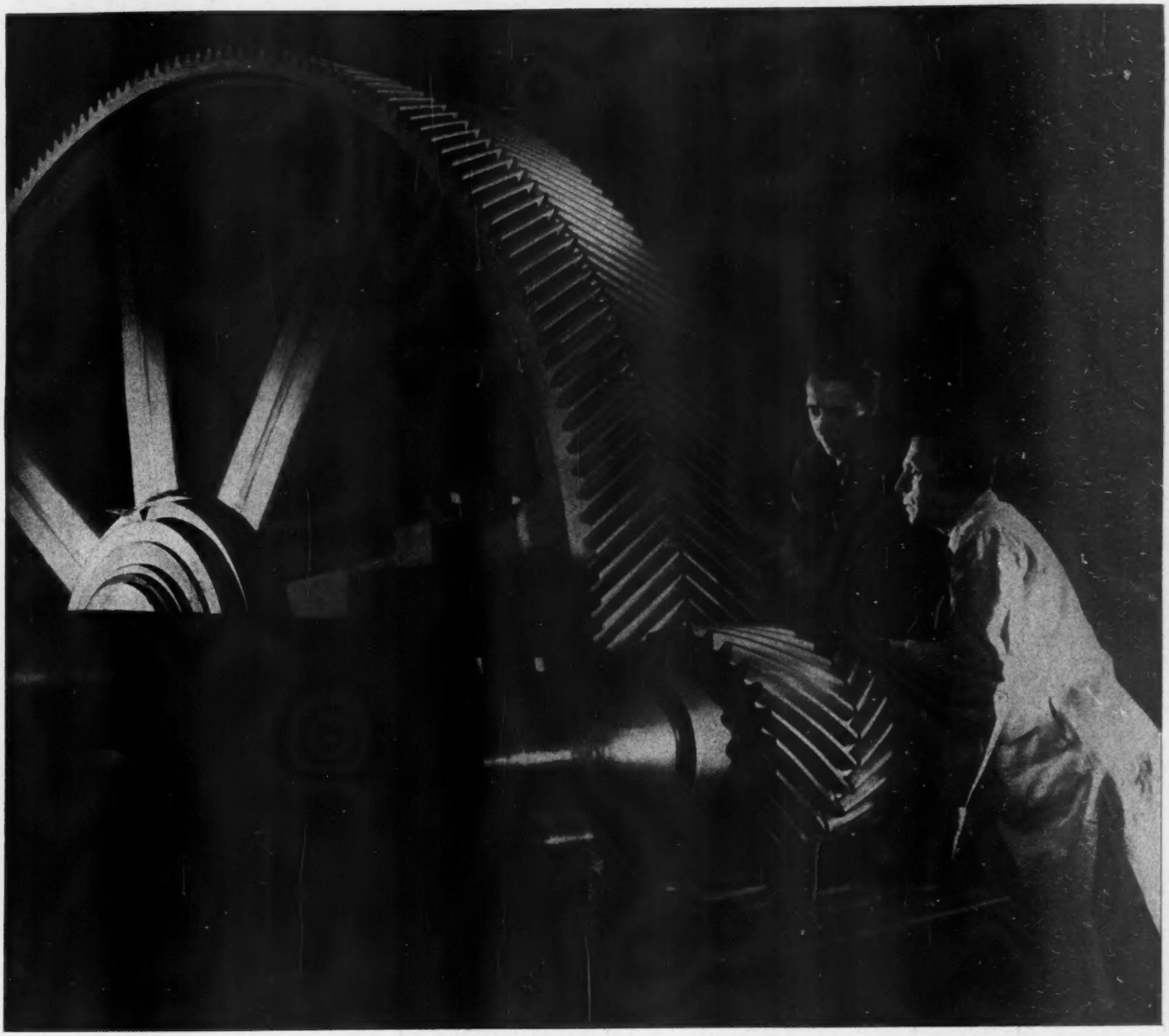

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The top gear today, of course is made by David Brown — just as it has been for one hundred years. And there's a good reason for this universal approval of a famous name — for David Brown make the biggest range of gears in the country. Everyone is fully proved and unsurpassed in its class for accuracy, quiet running and dogged dependability.
It adds up to this — more and more manufacturers are going straight into top with David Brown gears.

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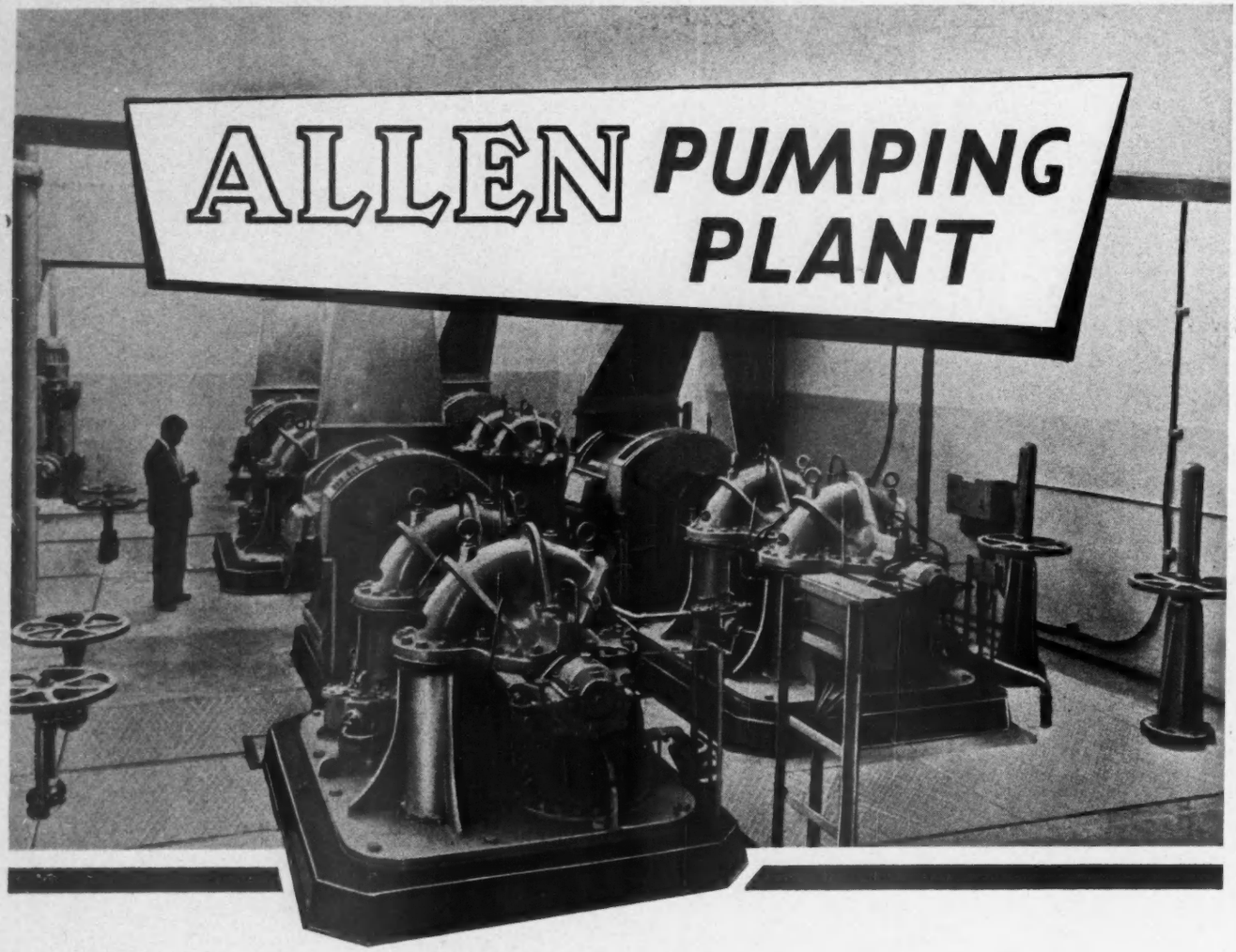


for Power Station service

The plant illustrated is in service in the Electricity Supply Commission's Highveld Power Station, Orange Free State, South Africa.

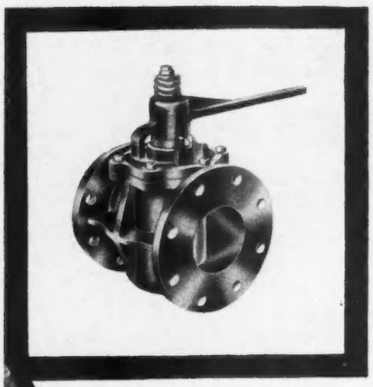
It comprises four Allen horizontal double-suction, two-stage pumps with 20/16-in. branches, driven by 1,245-h.p. M-V motors. Each pump is designed for a duty of 360,000 gallons per hour against a total head of 490 feet running at a speed of 1,485 r.p.m. These pumps are typical of a large number of ALLEN units installed for power station and waterworks service.

ALLEN centrifugal, axial and mixed flow pumps, horizontal or vertical, are designed to meet all requirements up to the largest capacity units needed in modern installations.

Specialists in complete Pumping Plant Installations

W. H. ALLEN SONS & Co LTD BEDFORD ENGLAND

Telephone: Bedford 67400. *Telegrams:* Pump Bedford Telex *(Telex No. 82100)*



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easy operating VALVES

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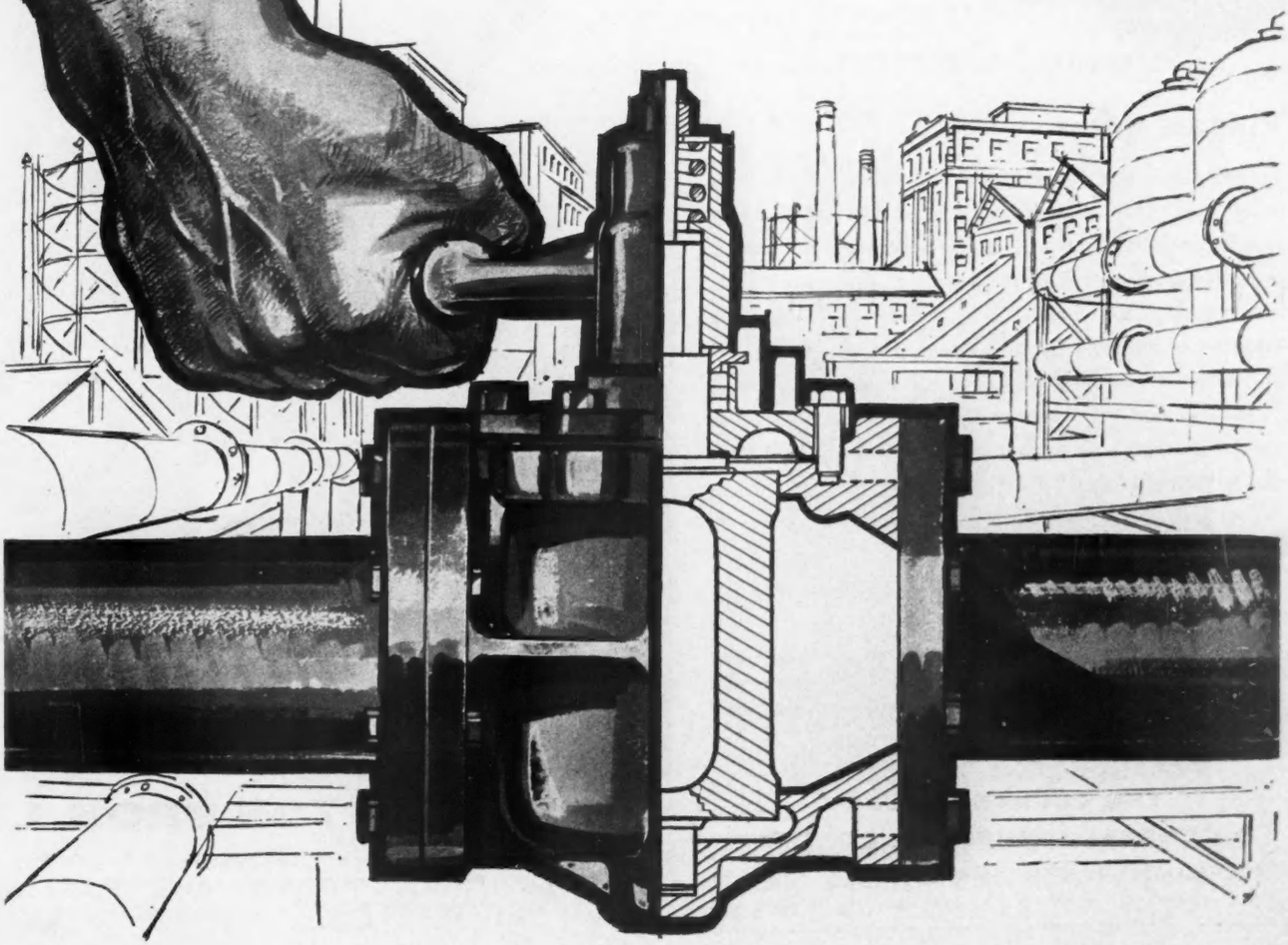
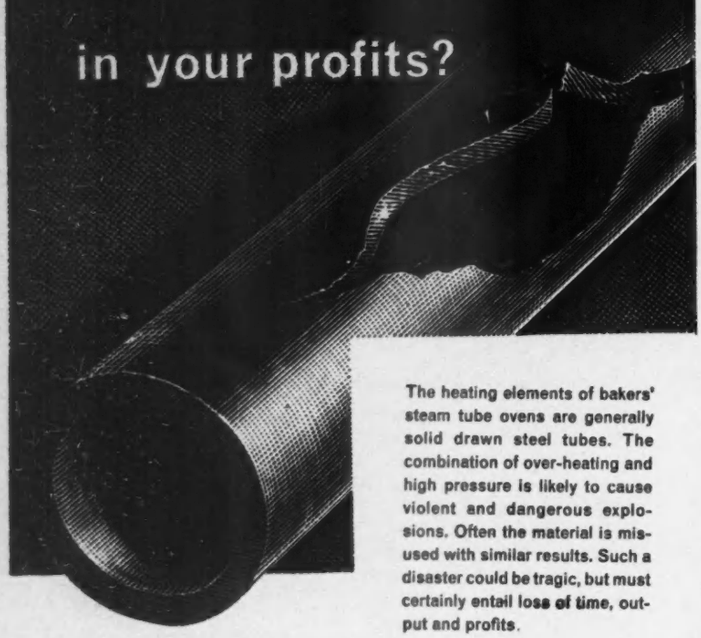


Did you know that this

bit of tube

could blow a hole

in your profits?



The heating elements of bakers' steam tube ovens are generally solid drawn steel tubes. The combination of over-heating and high pressure is likely to cause violent and dangerous explosions. Often the material is misused with similar results. Such a disaster could be tragic, but must certainly entail loss of time, output and profits.

Vulcan know

Overheating is one of many factors to cause explosions in ovens. The expert who knows them all, and just where to look for potential faults and danger spots—and not only in ovens—is the Vulcan Engineer Surveyor.

Industrial accidents need never happen if he regularly inspects machinery—your machinery. The inspection *and* protection of boilers and cranes, lifts and hoists is what Vulcan provide. It is a specialist's job. Vulcan are the specialists. That's why insurance brokers know that safety first is Vulcan first.

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New methods and the most modern foundry techniques backed by 64 years' experience in the production of high-grade malleable castings.

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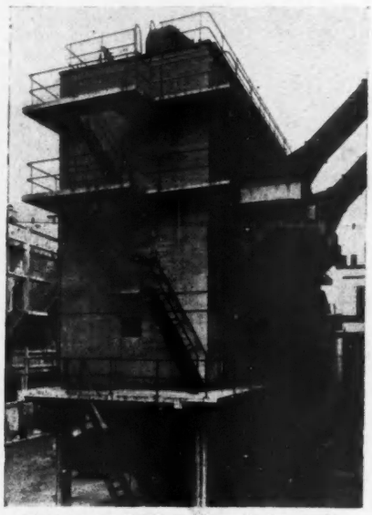
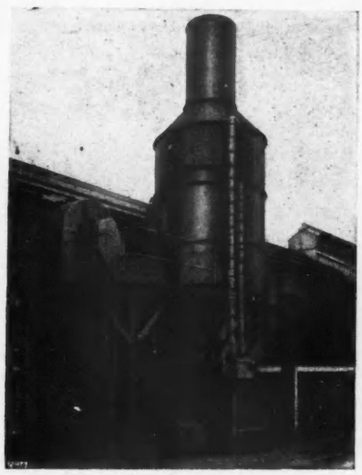


Electrostatic Precipitator collecting carbon dust.

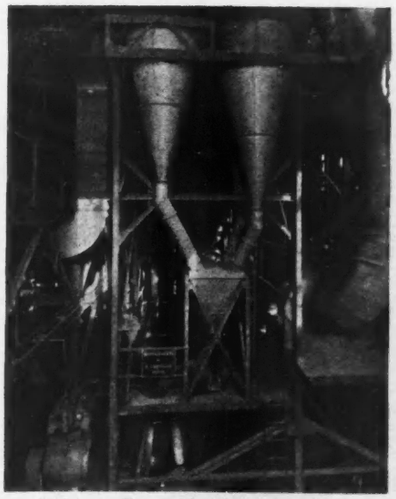
Complete Control of PROCESS DUSTS *is provided by* Sturtevant



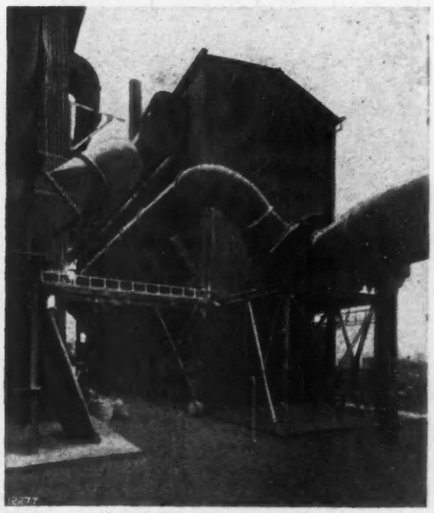
A Scrubber dealing with dust from a foundry shake-out.

DUST COLLECTION SYSTEMS

ALL types of process dusts are dealt with by Sturtevant, and dust collection systems embodying the most modern, efficient and economical equipment are designed and installed. Ranging from mobile self-contained units to overall plant installations comprising scrubbers, cyclones, textile filters and electrostatic separators, Sturtevant systems are supplied for small and large applications, however complex, **in every industry.**



Cyclones collecting dust from ore and limestone crushers, screens and conveyors.



A Textile Filter handling zinc oxide.

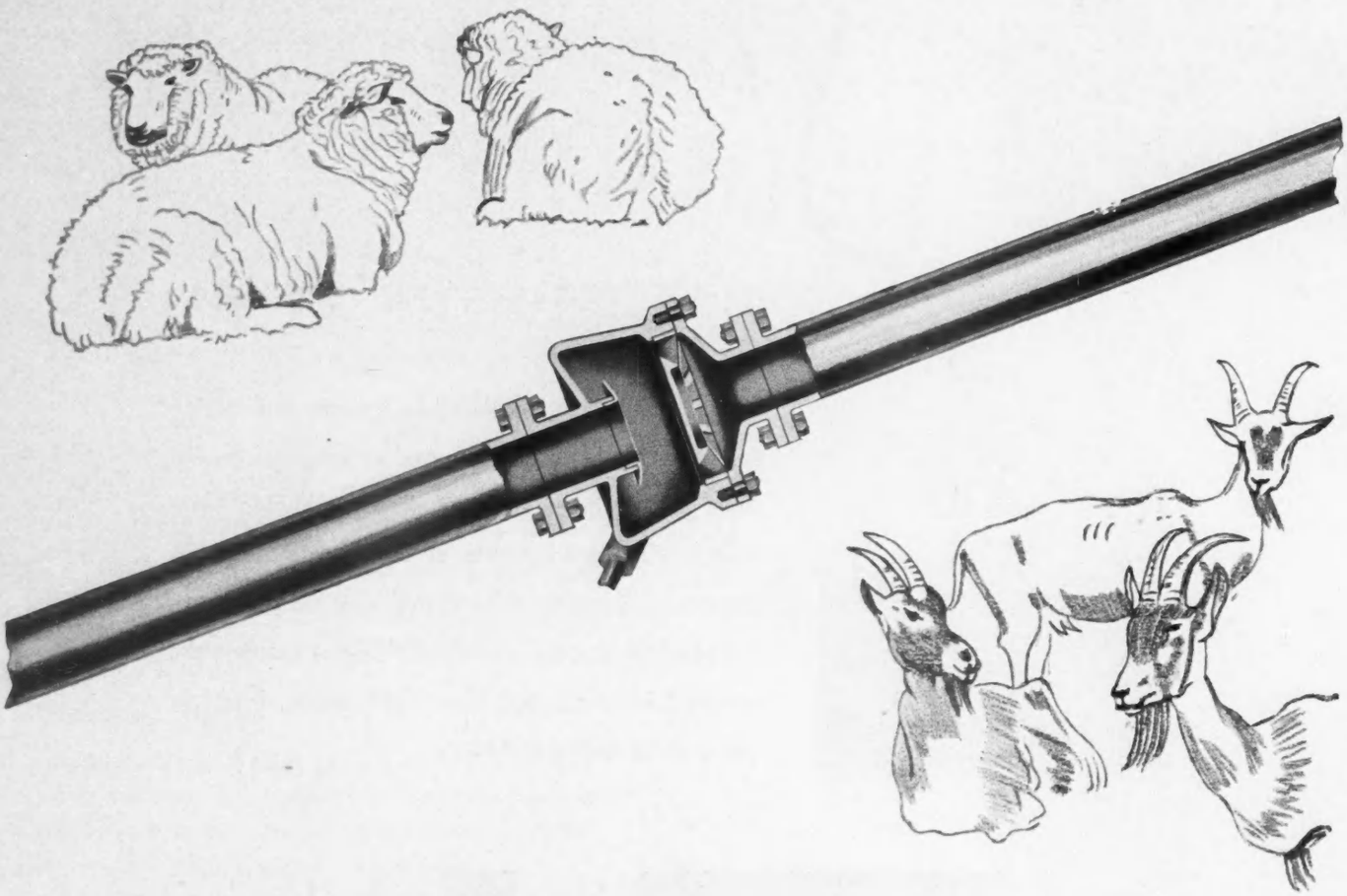
Sturtevant CLEAN AIR

Details of the characteristics and control of DUST are given in our publication D 2004 which will be sent on request.

STURTEVANT ENGINEERING CO. LTD., SOUTHERN HOUSE, CANNON STREET, LONDON, E.C.4

AUSTRALIA: STURTEVANT ENGINEERING CO. (AUSTRALASIA) LTD., 400 SUSSEX STREET, SYDNEY, N.S.W.

Sheep and goats!
Oil and Water!
it's all a matter of separation



We cannot deal with sheep or goats, but the 'Supreme Vortex' pipe line separator is unsurpassed for separating . . . .

Moisture **and oil drops from compressed air**
Moisture **from steam**
Dirt particles **from gases**

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SEPARATOR DIVISION

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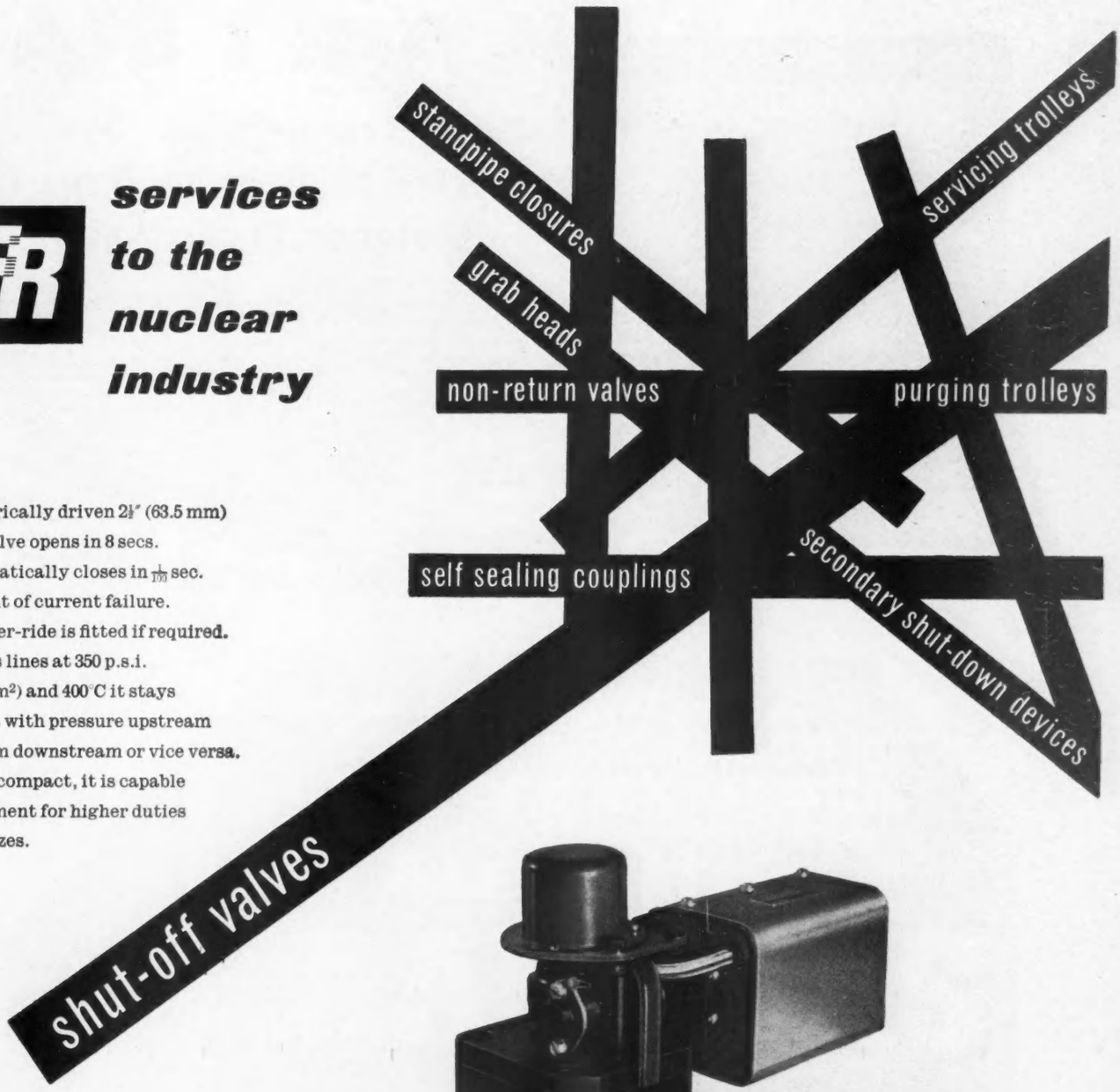
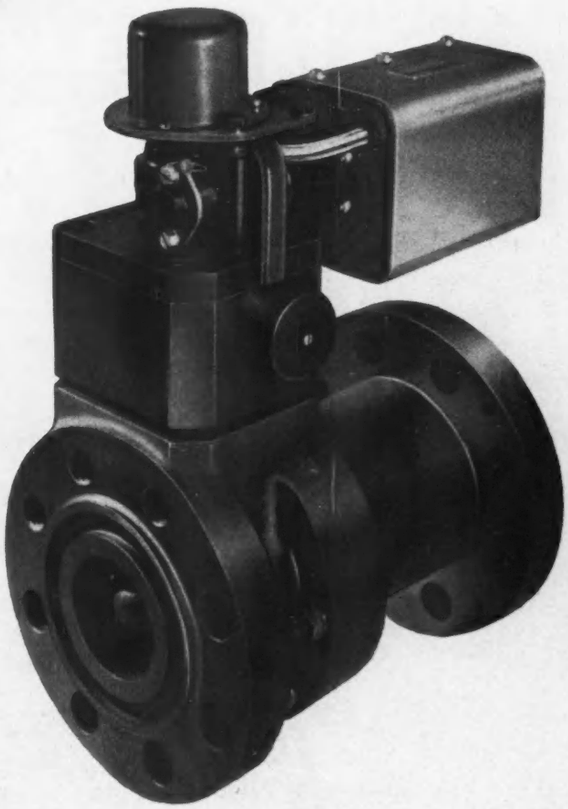
services to the nuclear industry



This electrically driven 2½" (63.5 mm) shut-off valve opens in 8 secs. and automatically closes in $\frac{1}{100}$ sec. in the event of current failure. Manual over-ride is fitted if required. Used in gas lines at 350 p.s.i. (24.61 kg/cm²) and 400°C it stays safely shut with pressure upstream and vacuum downstream or vice versa. Small and compact, it is capable of development for higher duties or larger sizes.



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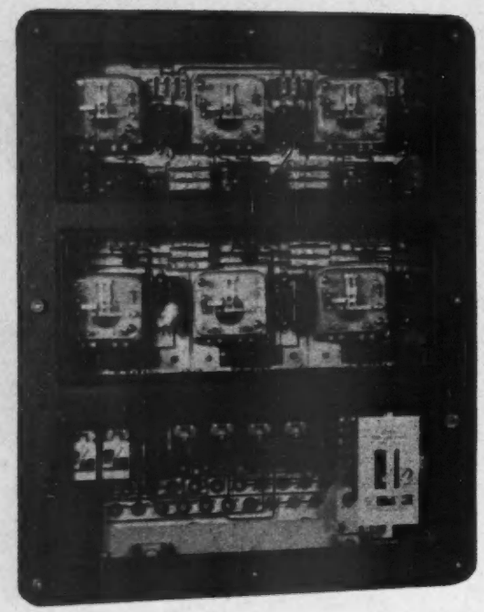
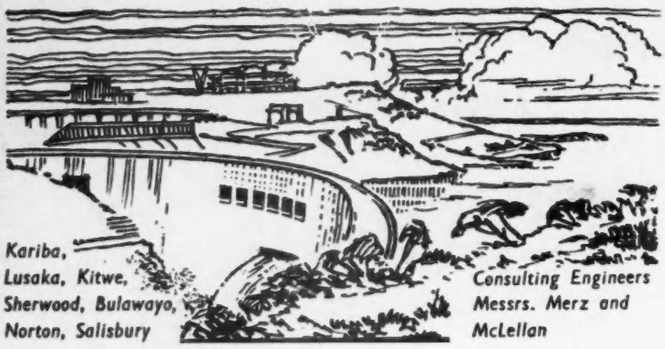


KARIBA

330-kV Transmission System Protected by Reyrolle Type-H Distance Protection



Kariba, Lusaka, Kitwe, Sherwood, Bulawayo, Norton, Salisbury

Consulting Engineers Messrs. Merz and McLellan

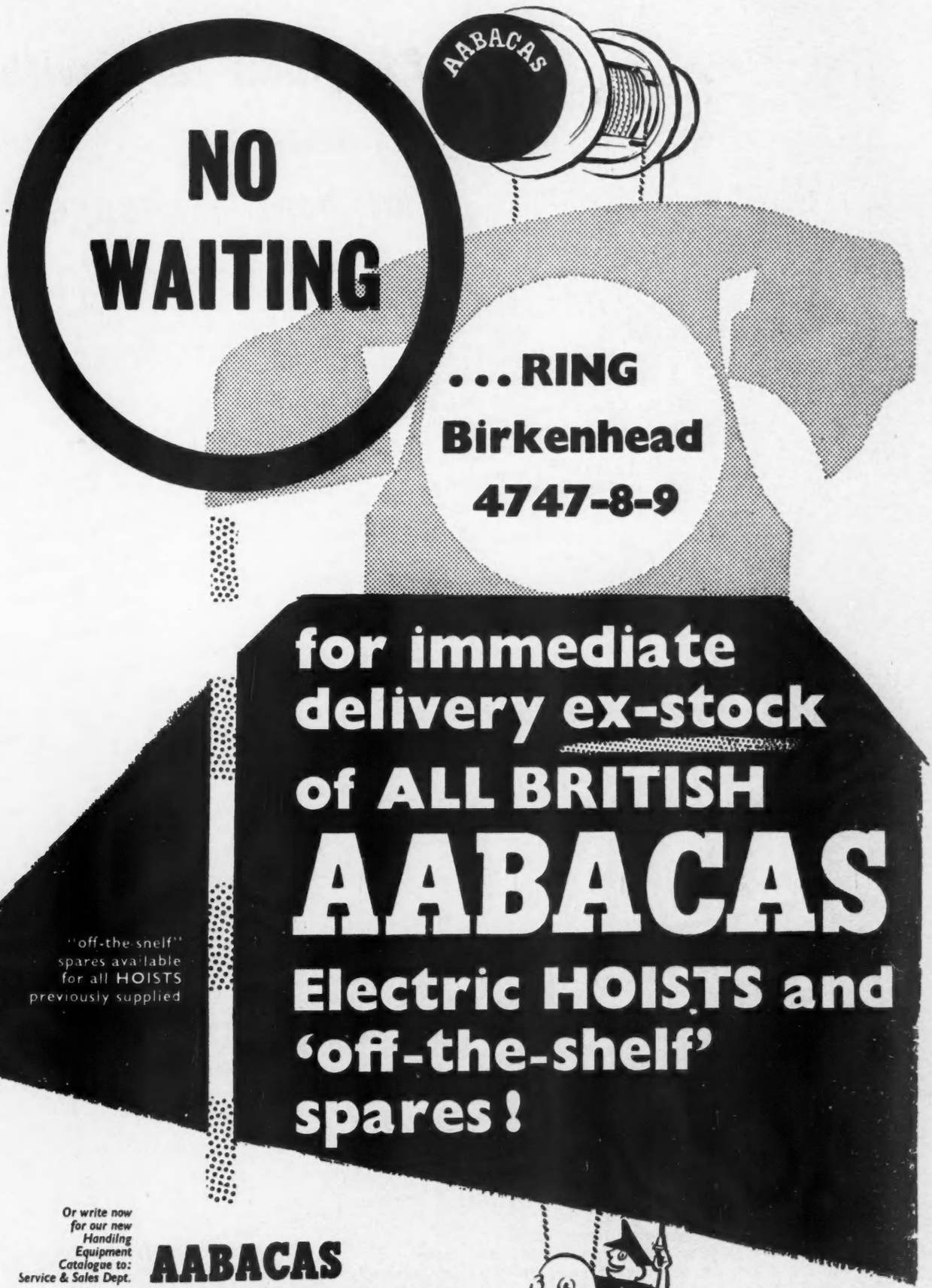
Reyrolle type-H high-performance distance protection incorporates the following important features:

- High speed for all types of fault
- Accurate measurement for exceptionally wide range of source to line impedance
- Negligible over-reach on D.C. transients
- Separate moving-coil elements for earth-faults and phase-faults
- All relay-elements identical and easily removable
- Self-contained design reduces panel wiring
- Built-in phase-selectors for single-phase auto-reclosing if required

Applied to major transmission lines throughout the world

Reyrolle

A REYROLLE & COMPANY LIMITED - HEBBURN - COUNTY DURHAM - ENGLAND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for immediate delivery ex-stock of ALL BRITISH
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Electric HOISTS and 'off-the-shelf' spares!
"off-the-shelf" spares available for all HOISTS previously supplied
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Plant Engineer faced with seize-up of heat exchanger!

He knew, of course, that scale had been building up for some time. But you can't keep shutting down such complicated plant every few weeks. Better, he thought, to wait until the job really *needed* doing—then get it over *fast*. This is how the situation was dealt with.

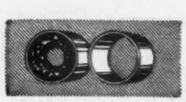
12 MON	10 a.m.	'Phoned General Descaling at Worksop. Outlined situation – stressed urgency and inability to dismantle. G.D. promised to send Engineer right away.
	1 p.m.	G.D. Engineer arrived, inspected plant and advised chemical cleaning as mechanical methods impractical. Took away sample of scale for analysis.
	4 p.m.	Received estimate and method of work from G.D. by 'phone. Approved on the spot. Ordered plant to be shut down.
13 TUE	1 p.m.	G.D. team arrived with equipment. First cleaning stage carried out, system flushed out. (Only existing outlets used!)
14 WED	8 a.m.	Second cleaning operation, and a final flushing out. Pumps and hoses disconnected.
15 THU	1 p.m.	Plant ready for normal working, and at full efficiency.

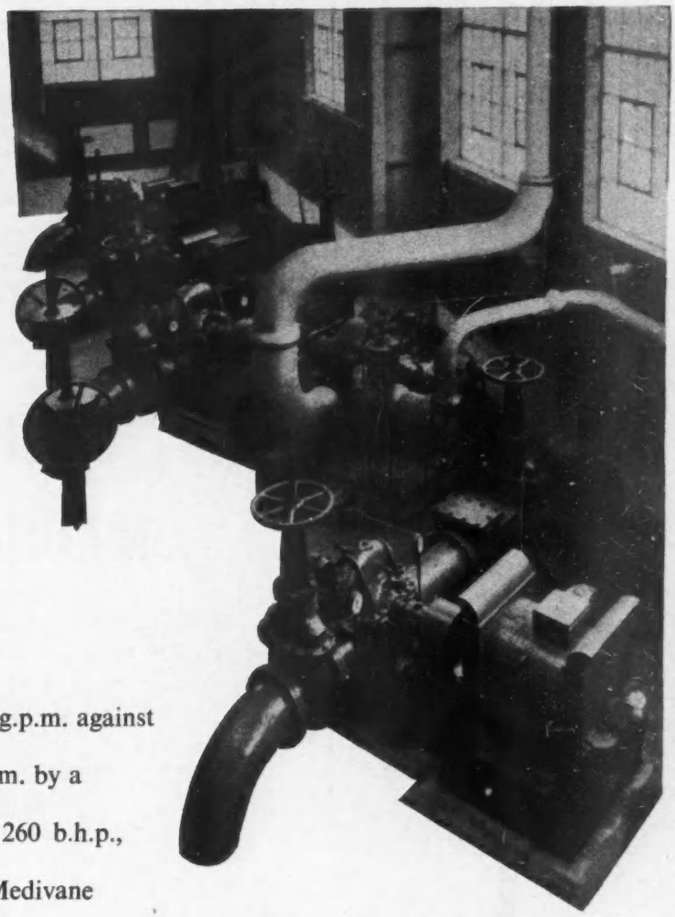
The G.D. Chemical Cleaning Service is the fastest and most effective way of descaling all *closed and complicated systems — boilers, pipe systems, condensers, economisers, towers, coolers and many other types of plant. Let us know of* your *problems, and if possible send a sample of scale.*

Fast and thorough chemical cleaning by

GENERAL DESCALING CO. LTD

RETFORD ROAD, WORKSOP, NOTTS. Tel: 3211/5 Telex: 54159





Mather & Platt pumps and motors on furnace cooling duty in the pump house of a large steel works. In the foreground is a 12″/15″ Medivane delivering 4,500 g.p.m. against a 140 ft. head and driven at 1,470 r.p.m. by a drip-proof squirrel-cage motor rated at 260 b.h.p., 2,750 volts; next to this is a 16″/20″ Medivane driven by steam turbine, and in the background are two 17″/20″ Lonovanes driven by drip-proof squirrel-cage induction motors.

PUMPS and MOTORS

for all Duties and all Services

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PARK WORKS, MANCHESTER, 10

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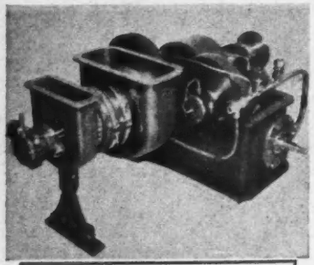
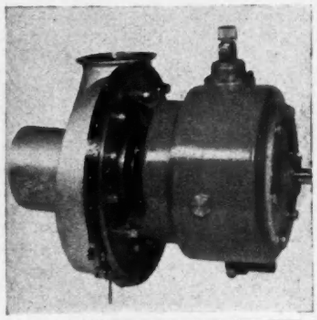
A31/1

Axial Flow Air Compressor

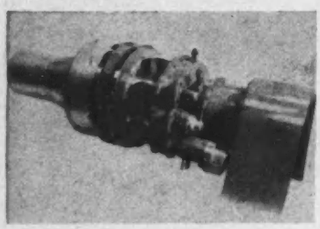


350 H.P. Turbine for Gasifier

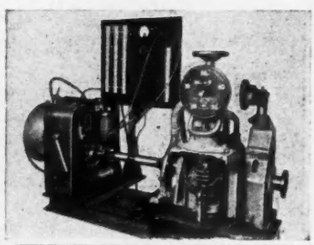


Radial Flow Free Power Turbine

GAS TURBINE DRIVEN MACHINERY



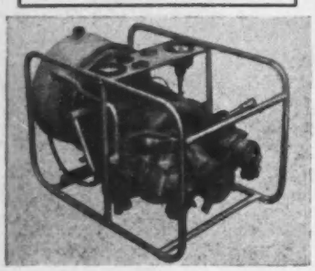
500 H.P. "Basilisk" Gas Turbine (Shaft Power and Air Bleed versions)



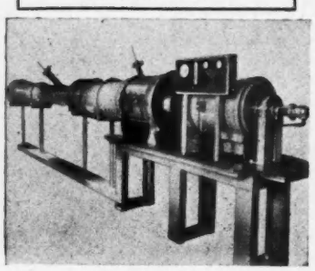
Instructional and Test Set

AXIAL AND RADIAL FLOW AIR COMPRESSORS

500 G.P.M. Lightweight Pumping Set



Axial Flow Compressor for Instructional Use



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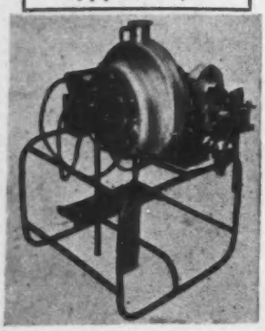
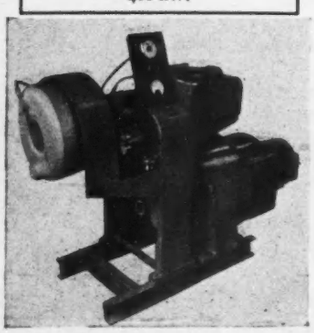
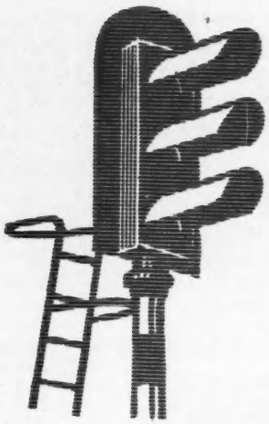


Generating Sets up to 400 kW.

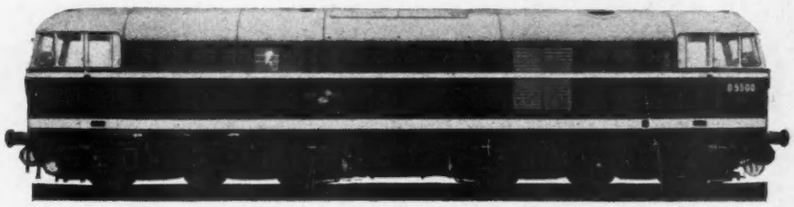


High Performance Suction Fan



a sound foundation for trouble free service

Motor Bogie frame supplied to Beyer Peacock Ltd. and W.G. Bagnall Ltd., for the 1,250 h.p. A1A-A1A Diesel Electric Locomotives built by the Traction Division of Brush Electrical Engineering Co. Ltd. for the British Transport Commission.



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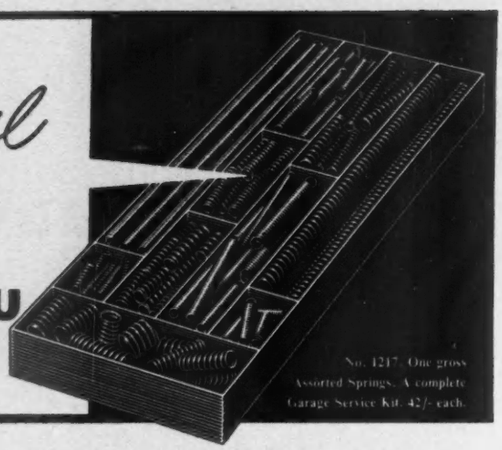

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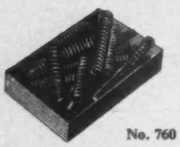

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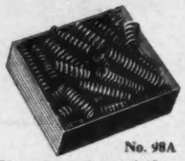

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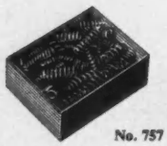
Three dozen Assorted 1" to 4" long, ½" to ⅞" diam., 19G to 15G. 5/6.



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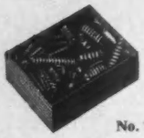

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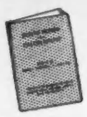

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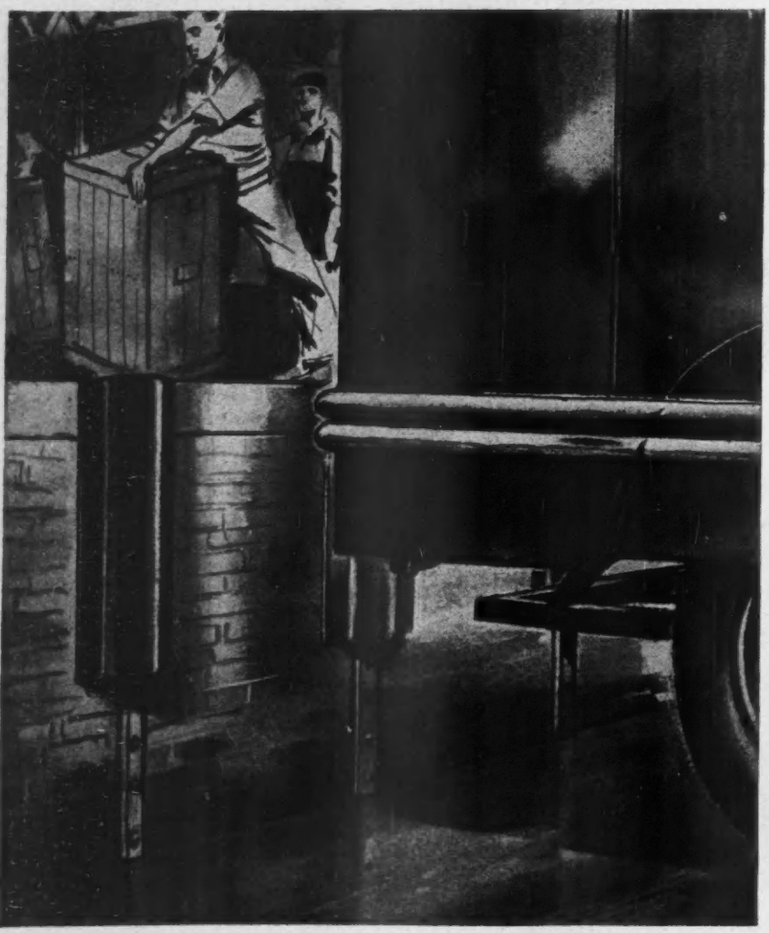

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ENGINEERING Impact

of Executive Ignorance

IT MAY be unbelievable, but British industry has the means within its reach to save £70,000,000 annually—and takes no advantage of it. For that much money, the London-Birmingham motorway could be built twice over.

The means in question are not a novelty but a technique that has been developed over the past ten years: the industrial application of radioisotopes. Savings between three and four million pounds annually are already being realised through sporadic application in chemical analysis, density and moisture content measurement, and thickness gauging. Dr. J. L. Putman, acting deputy divisional head at the Wantage Research Laboratories of the Atomic Energy Authority, says that without any new discoveries or added fundamental research, the savings could be increased by a factor of ten or more if the techniques were used wherever applicable.

That management does not read enough technical literature is Dr. Putnam's disturbing conclusion. Isotope techniques have been widely discussed in the technical and even the lay Press, yet the industry appears to be remarkably reluctant to grasp the significance. The Atomic Energy Authority finds it necessary to undertake missionary work on top of its efforts in fundamental and applied research.

In cooperation with the Institute of Directors a booklet *Isotopes at Work* has been prepared, which simply lists 350 industrial applications of radioisotopes. A mobile exhibit and consulting laboratory is now travelling up and down the country, spreading the gospel of radioisotopes, giving advice, and gathering information on further applications.

All this is done at public expense, and is necessary because executives do not always keep up to date through the technical Press with new developments.

Specialists from Two Professions

As a hospital patient lies under the business end of an X-ray machine, what thoughts crowd into his mind? Added to his ignorance of his body's condition is his ignorance of the strange machine above him. That battle with fear must be fought out by each individual patient, but an earlier battle was well fought and won—the battle of doctors and surgeons to acquire an understanding of new machines and of engineers to develop and improve them.

There is now a rapidly growing number of men in most industrial countries who have added the one specialism to the other. If some of the romanticism has vanished from, for example, locomotive engineering, a new adventurous life for the engineer is opening up in medical, surgical and biological work.

Look at some of the recent developments and innovations. At St. Thomas's Hospital medical school in London, a new electron microscopy centre is to be brought into use this summer. It is for research into the cause of rheumatic diseases, which are described as probably the principal cause of illness-absenteeism in industry.

Equipment has been developed for studying the servomechanism which controls the pupil of the eye, for analysing the oxygen content of the blood, and for examining the action of the heart as a pump. These advances could not have been made without electronic and other engineering techniques.

Economists and the Economy

There may still be employers who feel that asking an economist to help direct their business is about as relevant as expecting a teacher of grammar to write a successful play.

If there are, their number is decidedly on the wane. The large or medium sized firm without an economist, or at least an economic consultant, within reach, becomes decreasingly common.

What the economist does is not capable of certain answer. The academic member of the tribe may spend, or seem to spend, much time in lively debate on which way the economy is going. The only final answer is provided by events.

In industry the economist is likely to be engaged on less uncertain activities. Quite humble commercial research keeps many busy. Not all are concerned with the business of predicting what the likeliest markets are or should be.

An obvious benefit to the firm whose economist is well keyed in to the day to day management is his trained mind, able, given the opportunity, to interpret the significance to the company of trends at home and abroad.

In the United Kingdom economists in business have yet to make the contribution or achieve the position of their opposite numbers in the United States. In the Business Economists' Group they have a responsible body leading the way to a more general appreciation of what can be done by these relatively new boys in the management team.

Four Tons 200 Miles Up

That the Russians have "done it again" with the successful launching of the first so-called Spaceship Satellite is beyond question. Indeed, in some quarters it is believed that this puts Russia three years ahead of the United States in space exploration, thus proving that Russia's lead established when Sputnik I was launched in October, 1957, is not only being maintained, but even increased.

Whether the date of launching, 15 May, was contrived deliberately to fall on the second birthday of Sputnik III is not known, but there is little doubt that it was timed to coincide with the eve of the Summit meeting in Paris. The new spaceship is of course very much larger than any of its predecessors, with a weight claimed to be 4·1 tons, 2·1 tons being accounted for by a special cabin designed to take a man, and said to have a dummy man inside it. According to a Moscow broadcast, this cabin is equipped with instruments transmitting the physical conditions within so far as they would affect a man's life. However, the crux of the problem, that of recovery, is still unsolved, the main purpose of the new ship being, apparently, to test the cabin design.

of Peace, Plenty and Summits

Perhaps the most important outcome, even after all the uproar in Paris from an outraged Mr. Krushchev, is that there will be more frequent meetings at the Summit in future.

If that is so a fundamental change in the future for the engineering industries of not only the Western world could gradually take place. At a series of Summit meetings a disarmament agreement might or might not be signed.

Temporary alarms apart, such meetings could hardly continue without reducing the tensions between power blocks whose leaders were getting accustomed to talking across the table instead of bawling each other out through the medium of Press conferences.

In an atmosphere of reduced tension it would be only a matter of time before the defence budgets would begin to wilt. Manufacturing capacity would have to turn elsewhere for employment. With the continuing tendency for the proportion of world trade occupied in manufactured metal products to increase there need be no undue alarm about that.

What matters more, in the arduous business of becoming more competitive, improving our share of world markets, is that so much research in industry has been paid for by defence contracts.

A Government can survive the abortive spending of £65 million on a rocket project. The industrial group that lost that sort of money would be in the hands of the receivers, or its competitors. Yet on all sides the paramount importance of research and development is acclaimed, while there is an equally urgent need to achieve the highest quality in established products.

Beyond the Summits may lie a less threatened world but it will not be any calmer. A great deal depends on how we succeed in a voluntary economy in finding the money for improvement and advance. And in speeding the growth of the developing nations to whom more of industry will be turning for markets.

Iron and Steel above 1957 Records

As expected, the Iron and Steel Board's figures for the first quarter of the year in the steel industry confirm that from being run down steel stocks have changed to building up. The effect has been to add half a million tons to the pressure of demand on steel in the quarter compared with the year before.

Two hundred thousand tons of steel went into stock building in the first three months of the year. Last year half as much again was taken from the stocks.

Home consumption of steel for the quarter was almost 25 per cent up on last year, from 4·3 million tons up to 5·3. Adding in half a million tons for the stocks and another 300,000 tons on to exports, up from 800,000 to 1,100,000, the total demand was 6·6 million tons. This was fully met with only 300,000 tons being imported.

The board somewhat pessimistically combines the factors of increased overseas competition and higher home demand to predict that there may be some slight reduction in the amount of steel exported by the United Kingdom.

From the last quarter of 1959 to the first of this year steel deliveries have increased by a tenth. The only sectors not now above the previous record levels of 1957's last quarter are plate, rails, colliery arches and forgings and castings.

The vigorous activities of the car makers and the domestic appliance industry is reflected in a total home supply of sheet steel 46 per cent higher than in the first quarter of last year. Imports of sheet steel rose from 31,000 tons to 142,000 tons. Exports rose only to 104,000 tons from 83,000.

Apart from the increases in sheet and strip there has been a lively improvement in deliveries of rod for reinforced concrete. From 9,400 tons a week in the fourth quarter of 1957, deliveries improved to 11,200 a week in the last quarter of 1959 and 12,700 in the first of 1960.

and Serving your Time in Research

To become a corporate member of the Institution of Mechanical Engineers it is normally necessary to have had practical shop training or experience. Academic qualifications are not enough.

Another kind of training or experience is likely to qualify a man in the future, because the Institution are hoping to change the by-laws so as to admit "outstanding candidates working in the mechanical research field." In the current issue of the Institution's journal, the new President, Professor O. A. Saunders, F.R.S., sends a message to all present corporate members, explaining the proposed changes. A meeting to be held on 25 May will decide whether to adopt the new rules.

The Institution say: "it is a feature of the development of mechanical engineering today that progress depends upon the possession of precise scientific knowledge. There are some among those who increase our knowledge of the fundamental sciences of our profession who are promoting the development of mechanical engineering and should be members of our Institution."

The Institution still advise young people entering the profession to obtain practical experience, and they estimate that not more than 1 per cent of future candidates for election will offer the research qualification.

Just how important that 1 per cent can be is well illustrated by the Institution's choice of President for this year: Professor Saunders, after graduating, went to the Fuel Research Station in 1926, and has spent most of his time since then in research and education. But he has kept in close touch with the industrial aspects of mechanical engineering and is highly regarded in the profession and in industry.

By being willing to change their rules, the Institution are catching up with external change. Research is the most obvious type of experience for this special consideration. There is no sign that any other type of experience, such as management, will get similar consideration in the future.

Abrasion Won't Harm Basalt

Use fused cast basalt to get rid of worst abrasion problems. This advice is not fantasy but fact: if you don't believe it, read what other users have to say.

BASALT occurs naturally in several parts of the world, but the deposit most amenable to casting and annealing is at Kalenborn in Federal Germany. The value of fused cast basalt for abrasion resistant linings is widely recognised in Germany and in many countries throughout the world, and in recent years the material has made quite an impact on the United Kingdom market. Kalenborn fused cast basalt is imported into the United Kingdom by R. B. Hilton Limited of Greenwich who offer many standard tiles from stock as well as a service in fitting and installation.

Components are made by melting basalt at over 1,100° C and pouring it into sand or cast iron moulds. The surface solidifies into a glassy layer. Moulds are broken away when still red hot, and castings undergo complex annealing treatment for up to 60 hours, during which time any internal stresses are relieved and the material takes on a desirable internal structure.

Standard tiles are about 8 × 8 × 1½ in; the smallest is 8 × 3 × 1½ in, and the thickness can go up to 1¾ in. For purposes such as the linings of ball mills, they can be made up to 2½ in thick, but this is unusual.

Linings can also be made to drawings for particular applications. If non-standard shapes are required, the time from receiving customers' blueprints to receiving the special tiles is about two months. As a guide to design, the largest single castings should not exceed 15 lb and the smallest 3 lb in weight. They should be fairly constant in thickness and bends and corners should be designed with this in mind. Normally, fused cast basalt cannot be drilled for hanging or bolting. However, it is possible to cast tiles with holes to take countersunk bolts.

Linings for pipes are made either by normal casting with a thickness of about 1½ in, or by centrifugal casting to a thickness of about ¾ in. The maximum diameter in pipes is normally 12 in both for cast and spun, and the lengths vary between 10 and 20 in. Anything bigger would generally comprise two or more segmental tiles, but this size limitation depends only on control of the casting and annealing, and is steadily being raised.

Cutting is a very skilled job and is carried out in three ways. Hand cutting or chipping is really only suitable for minor adjustments in size of a new tile. Cutting with diamond or boron carbide abrasive wheels is absolutely accurate, but is expensive and can be a lengthy process because of the hardness of the material. Straight cuts across the central portion of flat tiles can be made by a Calor gas flame technique developed by R. B. Hilton. It is very quick and inexpensive and is reasonably accurate with practice, but 5 per cent or more rejects can be expected depending on the skill of the operator.

Tiles are bedded in cement mortar, usually about 0·3 in thick. Portland cement is normal, but for improved acid resistance where the tiles are not being bedded down on new Portland cement work, an aluminous cement is used. Such cements, however, are not the best for withstanding vibration, and are vulnerable to certain chemicals. Pyrinac resilient mortar withstands vibration, cushions mechanical shock, and has better adhesion than cement mixes, while other special mortars are made for resisting solvents such as ketones.

Properties of Fused Cast Basalt

Density	2·84 gm per c.c. (178 lb per cu. ft)
Thermal conductivity	7·24 Btu per sq. ft-hr-° F per in
Thermal expansion	Similar to cast iron
Thermal resistance	300° C, but suffers from thermal shock
Tensile strength	2,850 lb per sq. in
Compressive strength	71,000 lb per sq. in
Bending strength	4,250 lb per sq. in
Angle of slip	More favourable than steel

Users seem unanimous in commenting favourably on the life of fused cast basalt. Reported wear rates vary from a half to a fortieth those of other " wear resistant " materials.

A West German glassworks comment on use for pipes and bends for pneumatic transfer of silicates: " Only one bend had to be replaced because of a groove about 40 mm wide at the end of the bend. Experience has shown that pipes lined with fused cast basalt have about eight times the working life of ordinary pipes."

Pulverised fuel and hot gases at 100° C are conveyed in lined ducts at the ICI Metals Division, Kynoch Works in Birmingham. This installation was made in 1955 for feeding pulverised fuel to cyclone boilers and has carried at least 15,000 tons. It is still in service without need for replacement.

Kitteldeutsche Hartstein-Industrie AG, have used fused cast basalt for lining cyclones: " In 1954 we obtained two cyclones of 3 mm steel plate with a joint output of 960 cu. m per min. After three months of abrasion damage the cyclones had to be renewed. Then they were fitted with fused cast basalt. After six years these linings have fully proved themselves. The impressed numbers are still to be seen on the individual moulded shapes."

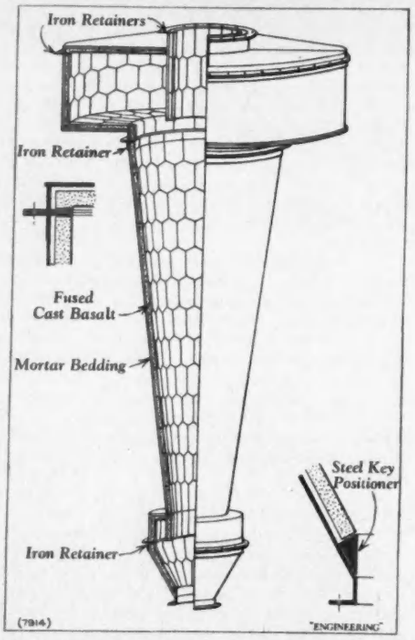
Chain conveyors are another successful application: Preussische Bergwerks-u. Hutten-AG wrote in 1955: " Lined troughs of the chain conveyor for moist mine waste handled 300,000 tons in a period of 2 years. Some conveyors, with softer products had a satisfactory life of 10 years and more ".

Most of the CEGB power stations use fused cast basalt; indeed, many of their sluiceways are lined with this material, while Northfleet power station has about 5,000 ft of pipe lined with it. Many large steel, chemical and mining works in Europe, India and the Far East have installed this material.

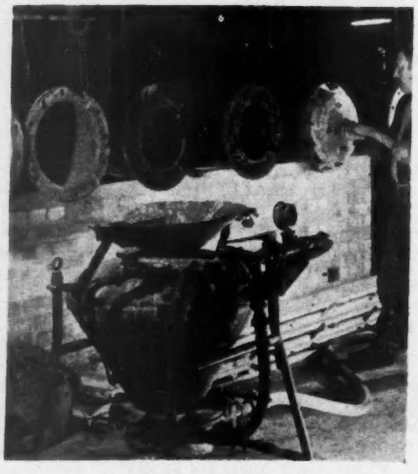
The rate of wear of fused cast basalt is so small that it can be used in ball mills for grinding paint pigments without fear of colour contamination. From Mitteldeutsche Emaillierwerke M. Fratschmer of Frankfurt comes this comment: " We use these linings not only for our priming mills but in particular for our white enamel mills. No colour impurities have been found, so in our opinion these tiles would be suitable for delicate colours."

Care must be taken to avoid heavy direct impact, and balls should not exceed 2 in diameter in ball mills. However, on the subject of breaking, a metallurgical works in Germany wrote in January, 1960: " The bunkered material consists of keenly sharp and glassily hard brown iron ore. Up to today 650,000 tons have gone through the bunker. So far there is no apparent wearing away of the fused cast basalt lining. Up till now not a single basalt tile has fallen out or been broken. Also, there is no sign yet of any small parts breaking off the sides of the tiles. By having fused cast basalt linings the amount of damp ore lying against the bunker sides and not going through is considerably reduced."

To end in the United Kingdom: for coke chutes. In one instance where 32 sq. ft replaced ½ in thick manganese-steel, the wear ratio was 9 to 1. In another, 123 sq. ft were lined with Kalenborn fused cast basalt instead of ¼ in thick carbon-steel, and this gave a wear ratio of 36 to 1. Is further comment needed?



(*Top*) *Lining of ore bunker in the Midlands.* (*Middle*) *" Specials " spell success for cyclones.* (*Below*) *Pressure grouting around tube linings.*



Hot Bearings Made from Cermet

Mixtures of metals and ceramics, known as cermets, are not living up to the high hopes once held out for them as the answer to high strength at high temperatures; an over simplification, perhaps, but true. Emerging from the work of Morgan Crucible Company, however, is a very promising use—for high temperature bearings. The one most suited for this is a 75 nickel-25 mullite composition which oxidises to give a shiny grey-black film at high temperatures.

This nickel oxide film performs satisfactorily without lubricant when run against a hard Stellited surface. It has the characteristic, though, that the oxide film is only self-repairing at temperatures above 500° C; below this, it is worn off and is abrasive, and at room temperature the coefficient of friction is 0·5. Morgan recommend that the oxide films on the Metamic cermet (it is grade 247) and the Stellite should be deliberately formed before running in.

So far, these bearings have operated satisfactorily under these conditions: pressure—up to 500 lb per sq. in; temperature—500 to 900° C; surface speed—up to 22 ft per min; with a coefficient of friction of about 0·3. These conditions, say the company, should not, however, be present simultaneously. The material has not been tested under high speed, low load conditions yet, but it is thought that it may be satisfactory providing the PV value is low.

Applications where this material appears promising are slow moving or intermittent high temperature bearings. It has been supplied on an experimental basis for the bearings of thrust reversers for jet engines, and also as a replacement for graphite in bearings for automatic stoker parts. Improved grades are being developed with self healing oxide films at low temperatures.

Properties of Metamic 247

Bulk density	5·4-5·6 gm per c.c.
Apparent porosity	Less than 8 per cent
Cold bend strength	$21{\cdot}6 \times 10^3$ lb per sq. in
Bend strength at	
500° C	$22{\cdot}8 \times 10^3$ lb per sq. in
800° C	$25{\cdot}4 \times 10^3$ lb per sq. in
1,100° C	$6{\cdot}3 \times 10^3$ lb per sq. in
Thermal expansion	10×10^{-6} per °C RT to 1,000° C
Thermal conductivity	0·036 CGS units
Hardness	200-250 VPN before oxidation 250-300 VPN after oxidation
Youngs modulus	$22{\cdot}5 \times 10^6$ lb per sq. in
Dimensional limitations	2½ in dia., 3 in long 2 in dia., 6 in long
Operating clearances	0·004-0·008 in, cold
Counterface material	Stellite 12

Morgan Crucible Company Limited, Battersea Church Road, London, SW11.

Thick Aluminium Plate Less Notch Sensitive

Highlight of a recent symposium was a test piece 12 ft by 6 ft of 2 in thick light alloy used for studies in brittle fracture. The symposium was organised by Northern Aluminium to promote use of aluminium in ships for carrying cargoes of liquid methane. Remember Methane Pioneer? It is for ships like that, to ply between Canvey Island and the Gulf of Mexico or the Middle East, only of ten times the size—in other words with about 20,000 tons of cargo.

The notch tests formed part of an investigation into properties of the 4Mg-Mn-Ti-aluminium alloy, B54SM, at temperatures down to −196° C. This was the first time that such comprehensive testing had been carried out on thick plate up to 2 in; prior to that, 1 in had been the maximum.

The result of breaking this large test piece, see the illustration, was to show that as the thickness increases, the system of stresses around a notch, even if it does become more triaxial, does not lead to more brittle behaviour. In fact at room temperature, the crack progressed slowly through the test piece with the metal yielding at a proof stress of about 10 tons per sq. in which closely resembles uniaxial tensile measurements. Other tests confirmed that fatigue lives, tensile stresses and elongation were higher at − 196° C than at room temperature which was to be expected.

Later in the symposium, representatives from shipping and fabricating firms were to hear that such thick plate was going to be needed in a tanker for carrying 15,000 tons of liquid methane. In a practical sense, Northern Aluminium have anticipated the need by building their new hot rolling mill at Rogerstone which will turn out plate 10 ft by 18 ft in 2 in plate. That is, everyone was convinced it would be needed until the design of a tanker was queried by fabricators of one of the methane land containers, APV, who thought the stiffening rings on cylindrical tanks could be dispensed with. The

result, though, was a starting point for detailed discussion with the knowledge that this aluminium alloy will be available in large sizes, and will not go behaving in an odd way towards notches. *Northern Aluminium Company Limited, Banbury, Oxon.*

High Vacuum Pump Uses Titanium Vapour

At high temperatures titanium is very reactive with all gases except the inert gases such as helium and argon. This is still true when it is in the vapour state; or even more so, because it will break down most organic vapours and combine with the component gases.

Thus a pump made by Consolidated Vacuum Corporation, in the USA, acts like a getter in an electronic tube, or like an oil diffusion pump, only it works on titanium vapour which when condensed is not revapourised. It is said to be able to create a vacuum down to 10^{-8} mm of mercury and can handle nitrogen at 1,900 litres per sec with rates of the same order for other gases including oxygen, hydrogen, water and organic vapours. It produces what is known as a "dry" vacuum and eliminates the need for extensive cold traps.

The centre of the pump is a source of titanium vapour. This comes from wire which is fed from a spool inside the pump on to a tungsten-tantalum alloy rod held at 2,800° C by electron bombardment. Electrons originate from a tungsten filament heated electrically.

Titanium vapour from this source moves outwards to the water-cooled walls of the pump, much as in an oil diffusion one. On the way it reacts with vapours and removes them from the system as solids. Around the walls, therefore, the titanium builds up into a microscopically thin film which is continuously thickening and entrapping gases.

Inert gases are removed from the system by a method which depends on electrically ionising them. This happens automatically in the area around the same tungsten filament which surrounds and heats the vapourising source. All that is needed is a grid-type anode to throw them outwards on to the solidifying titanium layer where they are entrapped.

The Evapor-ion pump works best at pressures below 10^{-4} mm of mercury. To get it down to this figure, conventional pumps may be used, but for closed systems, an oil or mercury diffusion pumping stage may be avoided by using an attachment fitted into the same pump which emits titanium vapour from a hot source but is not dependent on electron heating.

The pump is said to be capable of operating up to six months without need for breaking the vacuum or servicing. When this does occur, it is to replace the spool of titanium wire and to remove titanium deposits on the walls. The pump should be very useful for non-cyclic vacuum systems such as for betatrons, and particle accelerators, and also for systems which have long cycles in metallurgy, electronics and metallising. *Consolidated Vacuum Corporation, Rochester 3, New York, USA.*

Polyester Resists Glacial Acetic Acid

A new polyester resin combines the attractive property of resistance to fire with resistance to glacial acetic acid. This acid eats normal polyesters alive. Thus reinforced plastic products such as storage tanks, piping, scrubbers, columns, ductwork, and similar processing units or plant equipment can be made to withstand the chemical.

Acetic acid is used in the chemical, pharmaceutical, dyestuff and photographic industries where present resistant materials include aluminium, glass, and expensive metal alloys.

Resistance of Hetron 72, as it is called, to glacial acetic at 30 to 35° C is good. During recent comparative tests conducted by Hooker's corrosion laboratory, glass mat reinforced laminates based on Hetron 72 and on the same resin filled with about 2 per cent graphite were exposed to glacial acetic acid under static conditions at these temperatures. Edges of these laminates were not masked thus leaving glass fibre exposed.

The makers feel that the total weight gain is indicative of good resistance as also does the low rate of change in weight, at about 0·3 per cent per month. This is not believed to be significant, especially since the only visible evidence of attack appeared at the edges, which ordinarily would not be exposed to attack when used in such potential applications as storage tanks, tank trucks and piping.

From the tests, resin rich surfaces appear to be inert and virtually no loss is strength has been observed up to 60 days. Further tests are being made with these laminates and with others of similar composition but with the edges masked.

Hetron polyester resins were developed in America by the Durez plastics division of Hooker Chemical Corporation and may be obtained through Albright and Wilson in this country. *Albright and Wilson (Mfg) Limited, 1 Knightsbridge Green, London, SW1.*

Plastic Coated Steel

On page 356 of this journal in the issue of 18 March, it was erroneously stated that the makers of Platal plastic coated metals are Hoesch Walzwerke AG; this should have been Trierer Walzwerke AG. We apologise for the mistake.

Plain Words

By Capricorn

A WEEK ago I saw Madame de Gaulle launch the liner France. We were flown to St. Nazaire for the occasion, and as we banked over the estuary of the Loire, the vast and splendid ship came into view.

This was the child's-eye view. The image from childhood that shows an engineering work in its entirety, and draws the boy to take the first steps in choosing his profession. Why, I thought as we flew across the bows, does not the vision stay?

Not one man, from the chief designer to any master welder, could feel that he, he personally, had built that ship. Once it had been a concept in the mind of the designer, but with the onset of practical translation, the single image had long since vanished in complicated detail, too various to be encompassed by a single human brain.

But I, seeing it suddenly for the first time, could grasp the pure and elementary picture of the long steel vessel with its aluminium superstructure, black and white, as yet funnelless, poised, rearing slightly on the slipway, dominating the expanse of nearby sea and shipyards, waiting for the moment of her initiation, almost animate. To some she would mean the intricate assembly of piping, the location of machinery, drawn in section on crisp translucent tracing paper; to others the butted edges of flame-cut plate, chamfered ready for the weld, or descaled for the painter. To me, she was a ship.

But the image was extended when I later stood beneath the towering, curving bow, with the tear-drop swelling at its base; overhead on the immaculately welded hull the word "France" in solid letters of brilliant metal. The tricolour, the bunting, the countless little ships and helicopters, sirens, crowds, cheers, the band playing "Le Régiment de Sambre et Meuse," the Garde Républicaine with their black horsehair plumes on polished helmets. And Monsieur le Président.

And eventually the countdown. The silence as the last timbers are struck away. Madame de Gaulle, "la marraine du navire," the godmother of the ship, swings the splashing bottle, and the ship, with wax smoking on the slipways, glides, balanced incredibly on a tightrope, down towards a wafer edge of water, too shallow surely to carry such a vessel.

How sad that such occasions, though evoked by technical achievement, are not of its essence—almost as if, betrayed by romance during childhood into a livelihood of practical decisions, of measurements, disputes, and economics, we were reminded of the image that had set us on our course. The grand design, the ship, the dam, the bridge, the aeroplane, the locomotive—rich with the promise of heroic enterprise, submerged in argument and calculation.

Perhaps engineers should now and then step back and take a shot of mescalin to see their works as God—and children—see them.

Letters to the Editor

Apprentice Pay in Scotland

SIR, Mr. Ian Gordon says that he "would like to throw further light on the graduate situation in Scotland" (ENGNG., 15 April '60, p. 504) following Mr. Novy's article "Engineering Growth on Clydeside" (1 April, p. 446), which we, like many, have read with interest.

Shedding of light in regard to such an important subject and the illumination of such dark corners as may exist cannot be taken exception to, but your correspondent levels serious charges against the engineering industry in Scotland as a whole, which are either without foundation in fact or at best are based on half-truths. Such misrepresentation of conditions benefits no one and can only do harm to an important sector of the Scottish economy.

In dealing with the points raised by Mr. Gordon, I cannot do better than cite the example of my own company which I know to be typical of a large proportion of medium-sized concerns in Scotland.

Remuneration of student apprentices for the periods they are working at the factory are based on the nationally agreed rates. At the age of 21, however, the rate automatically becomes £8 0*s* 7*d* per week, and the majority of "sandwich" apprentices, therefore, enjoy this rate during their third summer at the works. Some firms, of which we are one, offer the student an alternative flat rate per week which, if accepted, is then paid to him for the duration of his training. In making comparison with the rates offered by English companies, allowance must be made for the subsistence factor, without which it is obvious that the majority of the boys could not afford to go so far from home. In this respect, we, ourselves, provide subsidised accommodation in a works hostel, which benefit does not reflect in the weekly wage rate.

As far as the planning of the practical training is concerned, regard must, of course, be had to the nature of the business and the facilities available, but here again we, as a typical example of the medium-sized engineering firms, undertake during the period of the student apprenticeship to provide experience in pattern shop, foundries, engineering departments, production control and work study departments, and drawing office. It is the responsibility of a full-time training officer to ensure that those programmes are fulfilled and to check on the progress of the various students. It is also the duty of this training officer, supported by myself and senior members of the technical staff, to maintain close contact with schools, universities and colleges throughout the country, and during the past year, several interviews have been conducted, not only in England, but in the remoter parts of Scotland. Our objective is always to give the student the best possible grounding in the practice of engineering with a view to his taking an active and useful part in the future of engineering, preferably within our own organisation.

As far as remuneration is concerned, our minimum commencing salary for a graduate is considerably in excess of the £500 per annum quoted, and any further consideration granted to honours graduates or specialists, whom we particularly desire to employ, would obviously be governed by their market value below which they could not be attracted, and by the importance of the work which we had in mind for them. The same considerations would apply in regard to special help for married men, and we know of no company in Scotland or in England which undertakes at the commencement of a student apprenticeship to provide additional help and remuneration in the event of marriage.

Many of the leading positions in engineering throughout the world are held by Scots who received their education at their own universities and technical colleges. They are the pioneers who have done so much to enhance the reputation of the Scottish trained engineer. Constructive criticism is helpful but Mr. Gordon, who may have been unfortunate in his personal experience, should beware of generalising without true knowledge of the facts, and I trust that in the interests of many Scottish engineering companies you will find space to publish this reply.

Yours faithfully,
D. A. S. MACLELLAN,
Technical Director.

Glenfield and Kennedy Limited,
Kilmarnock, Scotland.
9 May, 1960.

Redress for Awkward Loads

SIR, Both the authors of the earlier letters you published regarding transporting large loads by road (ENGNG., 4 Mar. '60, p. 313 and 18 Mar. '60, p. 377) were apparently angry and seem to have been somewhat blinded in so far as neither of them mentioned a sensible reason why awkward loads should be transported on the Queen's highways from one seaport to another seaport. I can imagine the unavoidable transportation by road from production plant to the site of installation or to a port, or from a port to the site of installation, but never from port to port.

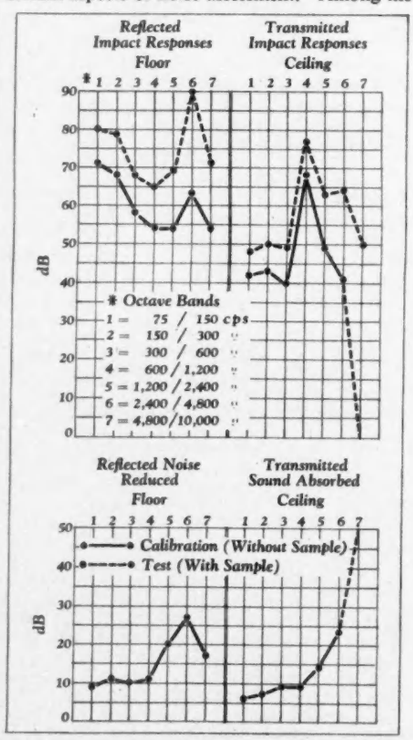
If this really should need to happen, I should like to know the reason and Mr. D. B. Welbourn may be right with his questions, but in all other cases I agree with Mr. Dudley A. Baker.

Faithfully yours,
FRITZ RUEF.

9 Bismarckstrasse,
Augsburg, Germany.
12 May, 1960.

Measuring Floor Noises

SIR, Since writing my article on "Taking Steps to Measure Floor Noises" (ENGNG., 13 May '60, p. 674), I have visited Western Germany where I had the pleasure of meeting Professor Dr. Karl Gösele, of the Institut für Technische Physik, in Stuttgart-Degerloch, and discussing with him certain aspects of noise assessment. Among the


Reflected Impact Responses Floor
Transmitted Impact Responses Ceiling
* 1 2 3 4 5 6 7
1 2 3 4 5 6 7
dB
* Octave Bands
1 = 75 / 150 cps
2 = 150 / 300 "
3 = 300 / 600 "
4 = 600 / 1,200 "
5 = 1,200 / 2,400 "
6 = 2,400 / 4,800 "
7 = 4,800/10,000 "
Reflected Noise Reduced Floor
Transmitted Sound Absorbed Ceiling
Calibration (Without Sample)
Test (With Sample)

Octave band analysis of impacts for 3·2 mm hessian-backed linoleum; with cement screed/concrete floor construction.

many interesting items shown me, was the manner in which reports are issued by his department.

After a careful study of Professor Gösele's method of reporting, I have decided to amplify and, I hope clarify, my own procedure in regard to graphs showing calibration and test results, and to the addition of graphical summaries of reflected noise reduction and transmitted sound absorption.

The graph reproduced here replaces Fig. 4 of the article in question and is self-explanatory. It gives in the revised form the test results of the sample previously shown in Fig. 4, on page 675.

Yours faithfully,
ERNEST G. MARKLEW.

R. H. Harry Stanger Laboratories,
Summerfield House,
Barnet Lane, Elstree, Herts.
11 May, 1960.

Grand Contour Canal

SIR, Since, in the correspondence on awkward loads, by Mr. M. J. Macfarlane and others, the Grand Contour Canal has been cited, perhaps you will allow me to clarify the position. This projected canal may be regarded as resuming where the old canal age left off, since the one-level idea was quite alive then and the old canal surveyors made much use of the distinctive 300 ft contour, as I explained in my earliest article in ENGINEERING (vol. 156, 1943, p. 281). But in another aspect, that of establishing Continental standards of barge navigation in this country, the dimensions provisionally proposed for the new canal, which are 30 m width, 5½ m depth and 7½ m headroom, would allow what are now awkward indivisible loads to be carried by ordinary barge transport up to 1,500 tons weight and 12 m least dimension.

There is no doubt that the use of large indivisible units will increase, and it is clear that works to build such units to any very extraordinary size will be located by marine wharves. However, due to the absence of locks along the 310 ft level of the Grand Contour Canal, it would be possible to convey much larger loads than 1,500 tons by overgauge arrangements. Thus a flat constructed to occupy nearly the full sustained section of the canal might be 50 m long by 25 m wide by 5 m draught, so displacing approximately 6,000 tons. Its progress would doubtless have to be from lay-by to lay-by, moving at week-ends. Since the length is not closely limited, still larger loads could be conveyed, if called for, by using a float which approached the limiting form which could be taken round the bends in the canal.

Yours faithfully,
J. F. POWNALL.

Porthcawl.
7 May, 1960.

Choosing One's Words

SIR, Capricorn's articles are wonderful, but I think he might have been a little more careful in his choice of illustration (ENGNG., 8 April '60, p. 472).

The efficient female assistant to whom he addressed his request for "a pound of pork sausages"—the normal type of request—would probably have (*a*) placed a 1 lb weight in the adjacent scales; (*b*) moved to the pork section of the shop; (*c*) taken the necessary sausages.

Since, however, he started his request with the word "sausages," she had to wait until he had finished his request before she knew whether he wanted (*a*) an ounce or a hundredweight; (*b*) to buy or to sell them; (*c*) discuss them generally; (*d*) ask her opinion of them.

Yours faithfully,
D. J. GROSSE.

14 Nursery Drive,
Banbury, Oxon.
8 May, 1960.

Road Materials and Construction

AS IN previous years, courses being organised by the Road Research Laboratory, Harmondsworth, to take place during the coming autumn, will deal with the fundamental properties of road materials and with the results of research into current problems and their application to modern practice.

It is proposed to run two courses on "Concrete," from 27 September to 6 October and from 11 October to 20 October, respectively; and two on "Bituminous (Including Tar) Materials," from 25 October to 4 November and from 8 November to 18 November, respectively. There will be two courses on "Soil Mechanics," from 22 November to 29 November and from 6 December to 13 December, respectively. The first of these courses will be followed immediately by a course on "Tropical Roads," which will run from 30 November to 2 December. A further course of "Tropical Roads," from 14 December to 16 December, will follow the second course of "Soil Mechanics."

Each course will be self-contained, and will carry an attendance fee of £12 12*s* which is payable in advance. Members of the courses on soil mechanics may attend the courses on tropical roads without further charge. Although the Laboratory has no living accommodation of its own, there are a number of hotels in neighbouring localities, details of which are available on request.

Further information and application forms are available from the Director, Road Research Laboratory, Harmondsworth, West Drayton, Middlesex (Telephone SKYport 1421). It should be noted that applications must reach the director by 7 July.

Exhibitions and Conferences

Applied Chemistry, Third International Exhibition.—Tues., 21 June, to Thurs., 30 June, in Belgrade. This event will be divided into several sectional exhibitions. Apply to the organising committee, Exposition de l'Industrie Chimique, Bulevar Voivode Misica 14, Boite Postale 48, Belgrade, Yugoslavia.

Royal Meteorological Society: Two-Day Discussion Meeting on Convection and Agricultural Meteorology.—Thurs., 30 June, and Fri., 1 July, at Queen's College, Dundee. Apply to the assistant secretary, Royal Meteorological Society, 49 Cromwell Road, South Kensington, London, SW7. Tel. KENsington 0730.

Electronics and Instruments Exhibition and Convention, 15th Annual.—Thurs., 7 July, to Wed., 13 July, at Manchester College of Science and Technology. Organised by the Northern Division of the Institution of Electronics. Apply to Mr. W. Birtwistle, general secretary, Institution of Electronics, 78 Shaw Road, Rochdale, Lancs. Tel. Rochdale 48759.

Rocket and Satellite Instrumentation, One-Day Symposium.—Thurs., 1 Sept., at Manson House, 26 Portland Place, London, W1. Organised jointly by the Society of Instrument Technology, 20 Queen Anne Street, London, W1. (Tel. LANgham 4251); and the British Interplanetary Society, 12 Bessborough Gardens, London, SW1. Tel. TATe Gallery 9371.

Space Navigation, One-Day Symposium.—Fri., 18 Nov., at the Royal Geographical Society, 1 Kensington Gore, London, SW7. Organised jointly by the Institute of Navigation, 1 Kensington Gore, London, SW7 (Tel. KENsington 5021); and the British Interplanetary Society, 12 Bessborough Gardens, London, SW1. Tel. TATe Gallery 9371.

Rocket Propulsion, Two-Day Symposium.—Fri. and Sat., 6 and 7 Jan., 1961, at the College of Aeronautics, Cranfield. Organised jointly by the College of Aeronautics, Cranfield, Bucks. (Tel. Cranfield 321); the Royal Aeronautical Society, 4 Hamilton Place, London, W1 (Tel. GROsvenor 3515); and the British Interplanetary Society, 12 Bessborough Gardens, London, SW1. Tel. TATe Gallery 9371.

Discovery of the Nucleus, International Conference on (Jubilee Celebration).—Mon., 4 Sept., to Sat., 9 Sept., 1961, at Manchester. Organised by the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, SW7. Tel. KENsington 0048.

Radio frequency Spectroscopy in Solids, Conference on.—Thurs. and Fri., 21 and 22 Sept., 1961, at Bangor. Organised by the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, SW7. Tel. KENsington 0048.

History of Science, 10th International Congress on.—Sun., 26 Aug., to Sun., 2 Sept., 1962, at Cornell University, New York, and the headquarters of the American Philosophical Society, Philadelphia, Penn., USA. Apply to the secretary, 10th International Congress of the History of Science, Cornell University, Ithaca, New York, USA.

Meetings and Papers

Association of Supervising Electrical Engineers

SOUTHAMPTON
"Electricity as Supplied to the Printing Trade," by S. C. Bellringer. Southampton Branch. Polygon Hotel, Southampton. Thurs., 26 May, 8 p.m.

Combustion Engineering Association

DUNDEE
"Clean Air and Industry." Discussion, with a panel consisting of Professor A. Mair, John Foreman and R. Sterling. At 10 a.m. "Water Treatment for Industrial Boiler Plant": discussion to be opened by David S. Kerr. At 2 p.m. Royal Hotel, 5 Union Street, Dundee. Tues., 24 May.

Institute of Fuel

LONDON
"Recommendations on Heights for New Industrial Chimneys," by G. Nonhebel. Institution of Civil Engineers, Great George Street, SW1. Mon., 23 May, 5.30 p.m.*

Institution of Civil Engineers

LONDON
"The New Highway Bridges Across the River Tigris in Iraq at Amara and Kut," by W. E. Gelson and G. A. Plank; and "The Analysis of Steel Decks, with Special Reference to the Highway Bridges at Amara and Kut, Iraq," by B. Farago and W. W. L. Chan. Tues., 24 May, 5.30 p.m.*
Film Evening: "London to Birmingham Motorway"; and "The Changing Face of Lincoln." Thurs., 26 May, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"New Semiconductor Devices and Their Possible Applications." Discussion, to be opened by Dr. A. F. Gibson and G. King. Electronics and Communications Section. Wed., 25 May, 5.30 p.m.*

Institution of Mechanical Engineers

LONDON
"Mechanical Aspects of Fractional-Horse-Power Motors," by P. G. Edkins. Annual General Meeting. London Graduates' Section. Tues., 24 May, 6.30 p.m.*
Special Meeting of Corporate Members to consider alterations to the bylaws of the Institution. Wed., 25 May, 6 p.m.

Institution of Plant Engineers

CARDIFF
"Controlled Maintenance," by G. E. Halter. South Wales Branch. South Wales Institute of Engineers, Park Place, Cardiff. Tues., 24 May, 7.30 p.m.
LIVERPOOL
"Packaging and Container Engineering," by E. Evans. Mersey and North Wales Branch. Exchange Hotel, Liverpool. Thurs., 26 May, 7.15 p.m.

Royal Institution

LONDON
"Luminescence: The Cold Light of Physics," by Professor G. F. J. Garlick. Wed., 25 May, 9 p.m.

Royal Society of Arts

LONDON
"The Retail Distribution of Electricity," by C. Robertson King. Last of three Cantor lectures on "Energy." Mon., 23 May, 6 p.m.*

Royal Statistical Society

LONDON
"Relationship Between Family Size and Family Expenditure" by F. G. Forsyth, instead of the paper by Dr. K. D. Tocher and A. Muir. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Wed., 25 May, 5.15 p.m.*

Society of Instrument Technology

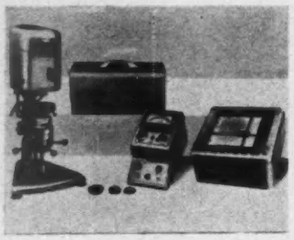
LONDON
Annual General Meeting, at 6 p.m. Presidential Address, at 7 p.m. Manson House, 26 Portland Place, W1. Tues., 24 May.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. An asterisk (*) is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Royal Statistical Society, 21 Bentinck Street, London, W1. (WELbeck 7638)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)

VISCOMETER

Automatic Recording



THE Ferranti-Shirley cone and plate viscometer has been modified to incorporate an automatic flow curve recorder.

The recorder is capable of plotting a complete shear stress/rate curve characteristic in about 10 sec for most Newtonian fluids. The manual construction of graphs is eliminated and inconstant experimental conditions are minimised.

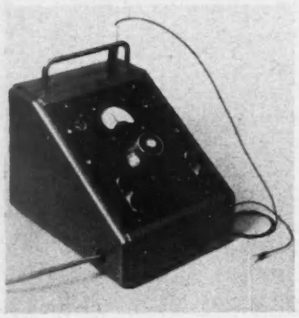
The new equipment comprises a flow curve recorder adaptor unit designed to fit beneath the existing viscometer indicator unit (so that all controls are readily accessible in one unit), and a Houston Instruments type HR92X-Y recorder. Other types of recorder can be used providing that their input characteristics are suitable.

There are 8 available rates of acceleration, the cone velocity being swept from zero to maximum speed (1,000 or 10,100 r.p.m.) in a time ranging from 10 to 600 sec with a linearity of about 1 per cent. Intermediate maximum speeds can be selected by a ten-turn potentiometer. A rapid acceleration facility with a sweep time of about 1 sec is also available as an overriding control. The sweep voltages are generated by a conventional Miller integrator.

Viscosity or shear stress can be recorded against time at a constant predetermined shear rate by utilising the sweep voltage as a time base in the Y axis of the recorder, with manual adjustment of the cone speed. The decay of stress with time can also be plotted in a similar manner. Normally the speed is reduced when maximum has been reached but a hold switch allows it to be maintained constant. *Ferranti Limited, Hollinwood, Lancashire.*

FIELD PLOTTER

Uses Resistance Paper



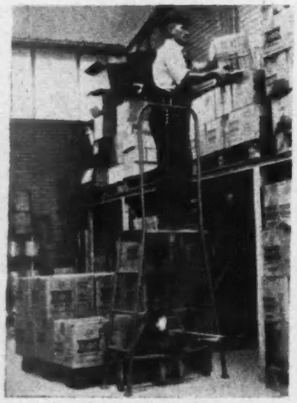
THE field plotter FP92 is an electric resistance analogue instrument which uses a special resistance paper to give lines of equipotential and current flow.

Conducting electrodes are painted on the paper using special paint and the circuit drawn out. A probe on the galvanometer is then used to measure the voltage at any point on the paper and thus a map analogy can be made. The accuracy is generally limited by the paper but 5 to 10 per cent can be achieved easily and 2 per cent with careful experience. Although less accurate, it is quicker and cleaner than an electrolytic tank. The instrument itself can discriminate voltage changes down to 0·1 per cent on a dial calibrated 0 to 1,000.

Great advantages are: low cost; the field is traced directly on the paper so that the record is made at the same time; the whole process can be done on a drawing board; no particular skill is required and the technique can be learned in an hour; the use of external resistances allows current feed for Poissons equation; the probe is a drawing pencil with 4H leads; there is a low range of 5 to 10 V for normal purposes and a high range of 50 to 100 V for current feed; the bridge method makes the measurements independent of mains variations; and the instrument is compact measuring 7 in by 9·5 in by 8 in high. It weighs 6¼ lb. *Servomex Controls Limited, Crowborough, Sussex.*

PALLET TRUCK

With Stores Ladder



A NEW development is a pallet truck with a spring loaded stores ladder attached, ready for instant use.

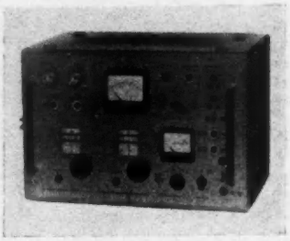
The truck has forks made of high tensile steel to carry heavy loads. All jointing pins are hardened and torsion proof. The fork rollers run on tapered roller bearings and the steering wheels on ball bearings. These latter wheels can be fitted with rubber tyres if desired. The axles are free to swivel to allow for uneven floors.

The pump and the hydraulic ram are an integral unit without exposed piping. The valves are easily accessible. As the pump piston works without a washer the amount of maintenance required is reduced, and as the cylinder is inside the oil container there is no external leakage. Control is by a three position pedal with raise, which also holds the handle in a high safety position; drive, where the handle is free of the hydraulic pressure; and lower, which allows the load to fall at constant speed.

The ladder has a height of 45 in to the platform which measures 21⅛ in by 11½ in. It rests on two springs which extend if anyone starts to mount and allow the four feet to rest on the ground. As soon as the load is removed the feet lift clear under the action of the springs. *G. Hunter (London) Limited, Gumley Road, Grays, Essex.*

FREQUENCY METER

10 c/s to 1,000 Mc/s



A FREQUENCY meter of high accuracy, type WIK, made by Rohde and Schwartz, is now being put on the market in this country.

The instrument covers the range from 10 c/s to 1,000 Mc/s. It is essentially a sinewave precision signal generator and comprises a crystal controlled frequency standard, a signal generator controlled by a frequency standard, a mixer, and a frequency indicator. These units together constitute a heterodyne frequency meter of high accuracy covering a wide frequency range. Although integrated in the one instrument the facilities offered by each unit can be used separately, thereby considerably extending the range of usefulness of the equipment.

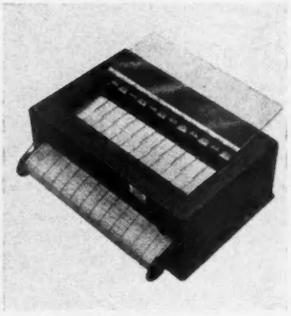
A special feature is that frequency variations can be observed on a pointer type meter and facilities are provided for recording frequency drift.

A frequency of 1 Mc/s is derived from either the internal or an external frequency standard, reduced by division to 100 kc/s and then distorted to produce a spectrum of harmonics 100 kc/s apart. A free running interpolation oscillator covering from 0 to 100 kc/s is then added to the selected frequencies obtained from the harmonic spectrum. The unwanted frequencies generated by this mixing process are filtered out.

Unknown frequencies can be simply and rapidly determined, and a radiated frequency can be measured by beating with the instrument output in a receiver. The warm up time is said to be short and the output is a pure sine wave at all frequencies up to 30 Mc/s. *Aveley Electric Limited, Ayron Road, Aveley Industrial Estate, South Ockendon, Essex.*

DIRECT WRITING RECORDER

12 Channels



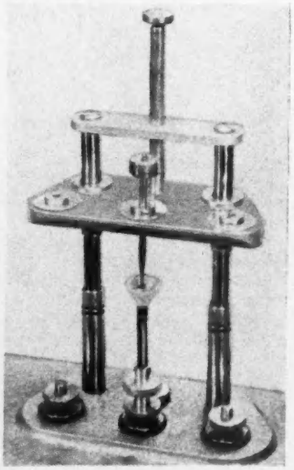
THE unit illustrated is one of a range of direct writing recorders with up to 12 channels.

It is a precision instrument for direct registration of low speed events. These events can be fed into the galvanometer units of the recorder as either alternating or direct current signals. The direct recording is made by heated pens working on wax covered paper. As the paper passes under the pens the heat melts the wax surface, where it makes contact, and exposes the bright red base of the paper. This forms a high contrast trace which is easily visible. Two event markers are provided in addition to the recording pens and may be used to note time or to make identification markings for special items.

There is a choice of three recording speeds, obtained by changing the gear wheels in the driving train. The range covered is from 1 mm per min up to 10 cm per sec. The galvanometers are centre tapped units and are available in four models with sensitivities of 25 mm deflection for currents of 1, 2, 4 or 8 mA. Corresponding internal resistances are 1,750, 430, 100 and 28 ohms. The recording paper roll is 383 mm wide (15 in approx.) and 90 m long (290 ft approx.) and weighs 3¼ lb. The recorder can be operated from 110/220 volts 50 cycles mains or from 12/24V battery. Its dimensions are 30·5 cm by 47 cm by 17·5 cm and the weight without paper 55½ lb. *AB Elektrisk Malmletning, Danderydsgatan 11, Stockholm, Sweden.*

PACKER

For Spectrochemical Samples



THE Elpac is an instrument designed to pack powder samples into carbon electrodes for spectrochemical analysis.

The packing portion of the apparatus is illustrated. It is mounted on a base containing a motor for driving the vibrators and a rheostat control to set the starting and running speeds. The machine can be preset to run for any time up to 90 sec.

An interchangeable electrode holder is fitted into the vibrator socket and a plastic funnel fits over the top of the electrode. These funnels can be disposed of after filling to avoid contamination of succeeding samples. A plunger runs free against the powder and can be weighted to suit. The main bracket can be raised or lowered to suit the size of electrode and the amount of the sample to be packed into it.

When the vibrator is started the plunger hammers the powder into the cavity and rams it evenly to the brim. It is particularly claimed that the packing is consistent between samples and that three electrodes can be machine packed in the time taken to do one by hand. *Hilger and Watts Limited, 98 St. Pancras Way, Camden Road, London, NW1.*

VACUUM GAUGE

Down to 0·1 Microns

THE Pirani vacuum gauge illustrated is one of a new range of Metrovac gauges that includes also ionisation and Penning-thermocouple types.

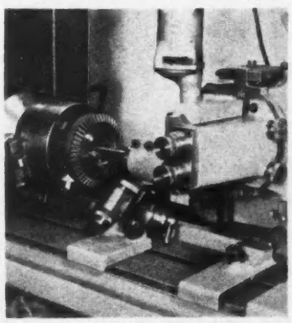
The principle of operation is that the heat loss from a heated wire is a function of the pressure of the gas surrounding it. The higher the pressure the greater the loss of heat and therefore the lower the temperature of the wire. A change in wire temperature is accompanied by a change in resistance which is measured and shown on the meter.

The VC6 is a portable instrument suitable for operation from 230V a.c., and is unaffected by normal mains fluctuations. The unit is housed in a pressed metal case with a panel mounted chassis for easy maintenance. The range switch and set zero control, together with a microammeter are situated on the front panel. Input plug, jack socket and sensitivity control are at the rear. To increase the accuracy of measurement two ranges of pressure are provided: 0 to 1,000 microns and 0 to 10 microns on a linear scale.

Normal sensitivity is such that a 10 per cent deflection on the scale corresponds to a pressure change of 1 micron. By introducing a galvanometer via the jack socket this can be increased so that changes of the order of 0·01 microns can be detected. An external recorder can be used. A model for use with five sensing heads is available. Other instruments in the range will measure pressure as low as 10^{-9} mm of mercury. The gauge head is demontable and filaments can be replaced if they should become contaminated. *Associated Electrical Industries (Manchester) Limited, Trafford Park, Manchester 17.*

INTERNAL GRINDER

For Splines



AN attachment is now available for use with Werner spline grinding machines to enable the flanks of spline bores to be ground.

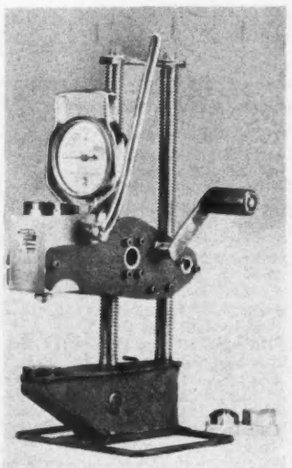
The normal grinding spindle and wheel dressing unit are removed and the attachment is mounted in the bore of the headstock. The grinding wheel is belt driven from a motor mounted vertically above the main housing. The cams for controlling the hydraulically operated cross movement of the internal spindle are mounted on the machine table.

The workpiece is held in a three jaw chuck mounted on the standard workhead. A fine adjustment is provided for accurate horizontal positioning of the spline grooves. The lower flank of the rear spline groove is ground on the left to right travel of the hydraulic table and on reverse the spindle is automatically traversed so that on the return stroke the lower flank of the diametrically opposite groove is ground. On completion of the cycle the head indexes automatically to bring the next groove into position. Thus one grinding pass is carried out on all flanks as the workpiece rotates through 360°.

A range of grinding spindles is available to cover bore sizes from $\frac{13}{16}$ in to $3\frac{1}{4}$ in diameter. After each complete rotation the grinding spindle is reset to make the next cut and the procedure repeated until the final dimension is reached. *Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.*

PORTABLE HARDNESS TESTER

3,000 kg Load



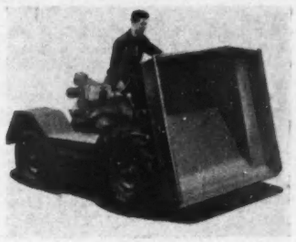
NOW available in this country is the King portable tester for determining Brinell hardness.

The instrument will apply loads up to 3,000 kg on a 10 mm ball under hand control. The version illustrated has a throat depth of 4 in and a gap 10 in high. It can, however, be removed from the base so that parts of any size can be tested. Vibration does not affect the accuracy. There is no inertia effect and the set load cannot be exceeded.

The test head is moved up and down the threaded posts by means of a crank handle. Away from the base, the test head can be held by any means capable of withstanding the 3 ton thrust of the ram on the ball. A C-clamp, yokes, chains and tie bars are all available to allow such testing to be carried out. Without the base the unit weighs 10 lb and the base adds another 16 lb. Alternative loads that can be applied are 500 kg, 750 kg, 1,000 kg and 1,500 kg. A 5 mm ball can also be supplied. A range of microscopes is available for use with the instrument and includes an open sided model with a lighting attachment. *Foundry Suppliers Limited, 25a Cockspur Street, London, SW1.*

DUMPER

For Rough Conditions



THE "Red Devils" are two new dumpers jointly produced by Boydell and Winget for operating in very rough conditions.

The larger of the two (illustrated) has a capacity of 22½ cwt and the smaller one, of 15 cwt. On both models the chassis is doubled at the front for strength and freedom from torsion; there are no belts or driving chains and the steering column assembly is extra strong. The weight distribution on the front wheels has been designed for operating on bad sites.

A crane skip equipment supplied as an alternative to the standard unit, has a cradle attachment that enables a bottom discharge skip to be used. The arrangement allows the skip to be automatically placed or picked up from a transfer frame so that loaded skips can be exchanged for empty ones without loss of time.

The 15 cwt model, the 2-S, is driven by a Petter AVA1 engine of 6 h.p. or a Lister LD2. The drive is through a four speed constant mesh box with a built-on reduction unit to a hypoid axle with 4-star differential. The steering axle is pivoted to give 20 in of articulation and is carried on rubber bushes. Ackermann steering gives a turning circle of 21 ft.

The 22½ cwt model, the 3-S, has a Petter PH1 engine of 8½ h.p. driving through a three-forward and one-reverse box. The steering axle is a solid beam centre pivoted and controlled by radius rods. Steering is by cam and roller with nylon bushes on the ball joints giving a turning circle of 23 ft. As in the 2-S the standard skip is the self tip and return-to-catch type. *Winget Limited, Rochester, Kent.*

TONG-TESTER

For Confined Spaces

TYPE 618 a.c. Milliclamp is a tong-tester designed to measure the current flowing in small conductors without breaking the circuit.

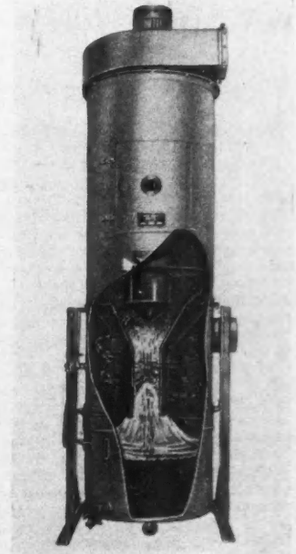
The probe has been reduced in size to that of a large crocodile clip on the end of a flexible lead so that it can be inserted in instrument wiring. It is particularly useful for transistor circuits.

The clip-on probe forms the secondary of a transformer whose single-turn primary is the current-carrying conductor. Negligible impedance is reflected back into the circuit under test and the voltage output is proportional to the primary current over the range of frequencies from 10 c/s to 200 kc/s. The signal is amplified and fed to a valve voltmeter for measuring the current or to an oscilloscope for monitoring the wave form. There are three current settings covering the range from 50mA to 20A full scale, for a voltage output of 1V in each case. The accuracy is ± 3 per cent for currents above 1mA. The maximum output is 1V into 10 kilohms.

The instrument is fully transistorised and may be operated from mains or dry batteries which weigh about ¾ lb and give 50 hours operation. Overall dimensions are 6 in by 5¼ in by 8¼ in high. With batteries the total weight is 6 lb. *Dawe Instruments Limited, 99 Uxbridge Road, London, W5.*

DUST COLLECTOR

Wet and Centrifugal Actions



THE Handte range of wet dust collectors is now being made in this country.

The units combine centrifugal and wet collection as the dust laden air enters tangentially and the heavier particles are deposited in the water by the same centrifugal action which also causes the water to break up into a rain. Smaller particles are thoroughly wetted and a centrifugal water eliminator returns the drops to the sludge bin. The cleaned air can be returned directly to the room.

Efficiency of the unit ranges from 100 per cent for particles above 4 microns to 89·5 per cent for particles between 1 and 1·5 microns. There are eight standard sizes, with capacities from 300 to 5,000 cu. ft of free air per minute against water gauge pressures of from 4·5 to 8 in. The largest unit has a height of 13 ft 9 in and a diameter of 5 ft with a sludge bin 2 ft deep and 5 ft diameter. The power of the driving motors ranges from ¾ to 12·5 h.p. *The Visco Engineering Company Limited, Stafford Road, Croydon, Surrey.*

Mechanical Handling Exhibition

THE seventh in the series of Mechanical Handling Exhibitions closed at Earl's Court on 13 May. It was well attended and was notable for the range of items on show. One of the advantages of specialist exhibitions is that not only are many types of equipment presented but also many variations of each type. This allows the visitor to make a selection that comes nearest to his immediate needs and provides designers with some idea of where gaps in the ranks occur. Several of the items displayed were described in our issue of 13 May and some more are given here.

DOCUMENT CONVEYOR

A DOCUMENT conveyor consists of one or more channels with a constantly moving belt beneath them.

The channels are very narrow and can be mounted in banks side by side. Documents are placed in them on edge and project above the top. Corners can be sharp as the belts will take a very small radius and the documents themselves will also bend.

A typical example has a conveyor 76 ft long with ten lanes. The six outermost lanes move cards from the telephone desks to the processing tables, while the centre four return information in the other direction. The troughs are 5 in deep and 1 in wide so that the cards travel in an upright position supported by the walls of the lane and resting on ⅛ in wide moving belts. *Lamson Engineering Company Limited, Hythe Road, London, NW10.*

LIFT TRUCK

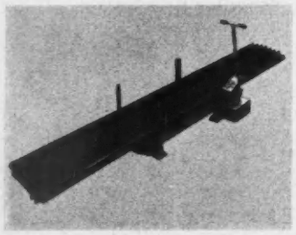
For Long Loads

THE lift truck illustrated has been designed specially for handling very long loads.

By offsetting the steering handle and pump the direction of travel has been maintained with the length of the load so that it can pass through narrow gangways. The truck is available with two sizes of wheel giving lowered heights of 6 in or 8 in. The hydraulic ram and pump are two separate units joined together by a heavy duty flexible pipe. The pump is of the double acting type and is fitted with its own handle which allows operation to be carried out in confined areas.

The pump is fitted with a pressure release valve, safety stops and a variable speed of release. The pump unit is held in position by two bolts. The ram is of the medium pressure type and is held in place by two horizontal pins. Replacement of either ram or pump can be carried out in a matter of minutes.

The truck is fitted with a full swivel twin wheel castor unit which has a



double ball bearing head. A T-type tubular handle is spring loaded to the upright position and has two rubber handles. A push and pull handle support is provided to enable manoeuvring in confined areas. Wheels are available either as cast iron, rubber tyred or Duthane tyred.

The size of the lifting platform is 48 in long by 18 in wide and the amount of lift is 3 in. The maximum width of load that can be carried satisfactorily on the truck is 26 in and the maximum weight is 2 tons. Standard long load stillages can be supplied. *Eccles (Birmingham) Limited, off Arrow Road, Redditch, Worcestershire.*

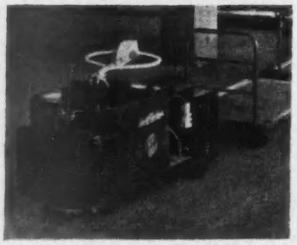
AUTOMATIC TUG

With Block Safety System

THE Robotug is a wire guided tractor system for goods deliveries which works on a safety block system.

The guiding wire is laid on or in the floor, according to whether the arrangement is required to be temporary or permanent, and energised by an alternating current of about ½ A. Sensing units in the tractor follow the wire and a steering motor is energised if the signals from the two units are unequal. If there is no current in the wire the traction motor stops and the brakes are applied so that failure is always to safety.

In the latest version of the system in which Conveyancer-Scott vehicles are used, the control unit in the tractor is also used to energise the section of wire ahead and de-energise the one behind. Thus there is always one clear section between any two tractors. The arrangement can be adapted for crossings to prevent collisions and also to control (or be controlled by) traffic lights where humanly controlled vehicles may meet the robots.



Each of the tractors has a programme unit which can be set so that the tractor will call at up to 75 stations following a selected route. Magnetic pick-up coils in the floor act as " points " to select the route according to the set programme. A number of different destinations can be programmed from a central dispatch point. The tractor will visit each in turn and finally come back to the starting point. In a simpler version, only a single destination can be set, with or without automatic return. The tractors are battery powered; as an alternative, platform vehicles can be used. *E.M.I. Electronics Limited, Industrial Division, Hayes, Middlesex.*

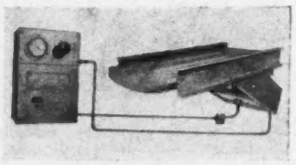
VIBRATORY FEEDER

Air Springs

THE Amplitrol vibratory feeder relies on air springs to maintain its natural resonance operation.

Power is supplied initially by a small standard size alternating current motor which has offset weights mounted on each end of its rotor shaft. The motor is mounted in a frame that has pneumatic springs, of a type similar to those used on transport vehicles, between it and the main frame of the vibrator. The tray is also mounted on another set of pneumatic springs. The rotating weights on the motor set up an out-of-balance force that builds up when the frequency of the tray reaches the natural resonance of the system so that the springs supply almost 90 per cent of the operating force.

In this application, air springs have a peculiar advantage in that their resonant frequency can be altered merely by varying the air pressure within the bag. This adjustment can be made while the vibrator is running, using a pressure reducing valve operated by a hand wheel. Therefore it is possible to change the



frequency of vibration of the tray and also the amplitude of movement to adjust the amount of feed and rate of passing material.

The feeder is designed to operate from any normal air line circuit having a pressure of not less than 80 lb per sq. in. If such a supply is not available then a small compressor unit can be supplied with the feeder. The consumption of air is small as it only occurs when amplitude changes are made, and running losses due to leakage are negligable.

The feeders are made in a range of sizes, and complete hopper units consisting of a flanged hopper, connection skirt plates, regulating gate, Amplitrol feeder and suspension and isolation supports are also available in a similar matching range of standard sizes. *Locker Industries Limited, Warrington, Lancashire.*

YARD TRUCK

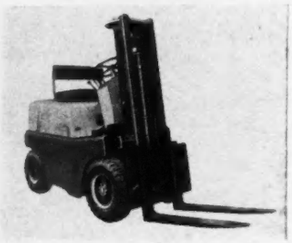
Capacity 4,000 lb

A NEW fork truck with a capacity of 4,000 lb at 24 in centres has been designed to suit outdoor conditions.

Power is supplied by either a Standard series 23 diesel or 87 mm petrol engine or by a Perkins P3 diesel engine. The drive is through a two speed forward and reverse gearbox and a quickly detachable clutch. The standard height of lift is 9 ft but optional masts are available with lifts up to 14 ft. Full free lift masts can also be supplied for low ceilings. There is a wide range of attachments.

Driving controls conform to automobile practice, the gear levers being hand operated. There is a hand brake for parking. A telescopic type steering wheel is fitted and is provided with an assistor handle to enable the driver to steer without constant shifting of his grip. The lift, lower, and tilt levers are mounted in the front scuttle and operate the hydraulic valves controlling the fluid flow to the jacks.

The truck has been designed for easy



servicing. Quick release panels are mounted on an all-steel fabrication of heavy section plate. The front end of the chassis is fitted with capped bearing brackets which form the drive axle mounts and also house the mast pivot pin. The drive axle is fully floating with single pneumatic tyred wheels. The differential is dip lubricated. The hydraulic brakes are the sliding shoe type. Maximum forward speed is 13·3 m.p.h. and maximum gradient 1 in 5. With a 48 in square pallet the outer turning radius is 80 in. The unladen weight of the truck is approximately 7,400 lb. *Conveyancer Fork Trucks Limited, Liverpool Road, Warrington.*

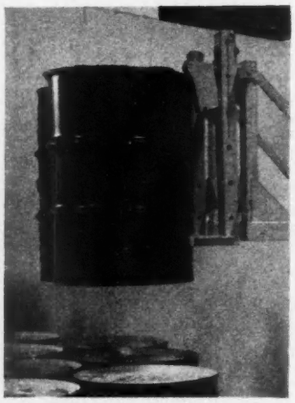
DRUM LIFTER

Automatic Grip

WITH the Grab-O-Matic gripping device 50 gallon drums can be handled with ease and speed.

The device consists basically of two jaws operating in opposition which grip the rim of the barrel. Swing back is prevented by forks against which the lower part of the barrel rests. Adjustments are provided to allow for handling any size of drum or barrel from 14 in diameter by 18 in high to the standard 50 gallon type illustrated.

In operation the grips are mounted either on the forks of a lift truck, for which a special framework is designed, or direct on the lift body with the forks removed. The truck is run forward until the gripping head makes contact below the rim and then the forks slowly raised. As the lower jaw of the grip strikes the under edge of the rim it is forced down and this movement brings down the upper jaw (by a cam action) to grip the upper and inner edge of the rim. The drum is now held firmly and is lifted with continued rise of the forks.

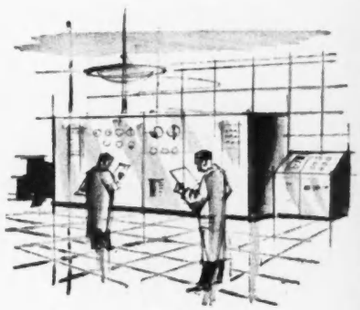


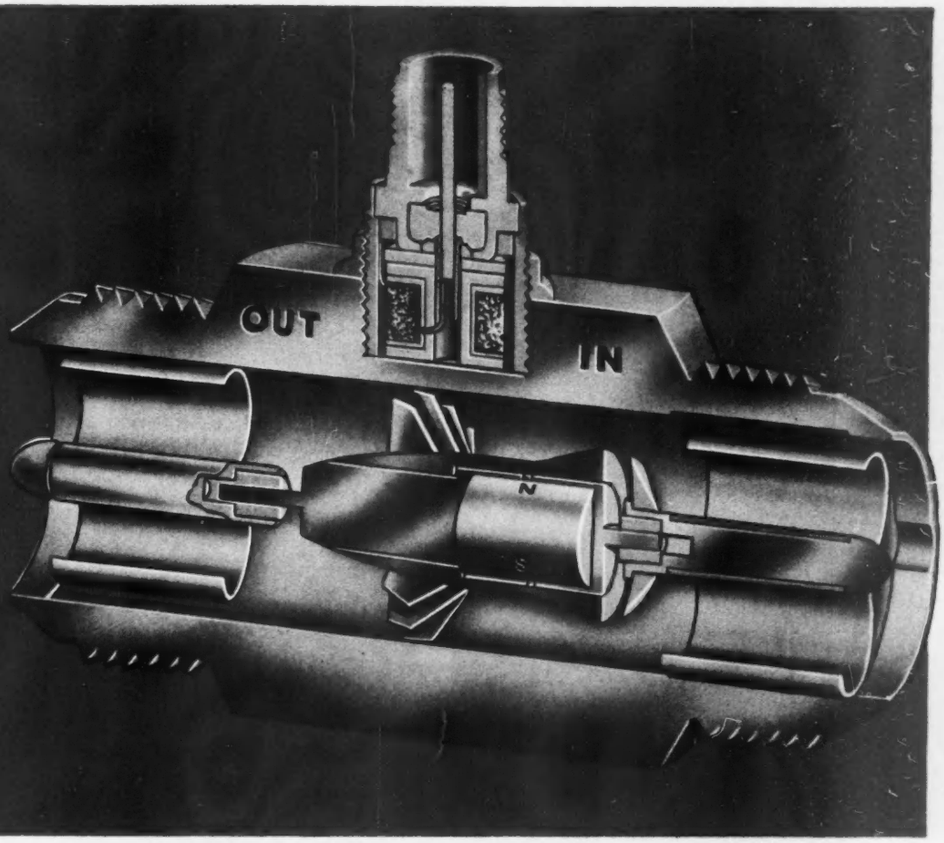
The illustration shows the frame being used with two grips attached so that two drums can be handled at once. No pallets are needed making a compact stack. Lowering the forks automatically releases the grip. *St. Clare Engineering Limited, Bridge Road, Lymington, Hampshire.*

Wherever information on fluid flow is required,

the de Havilland POTTERMETER

sets new standards of accuracy and reliability





This new turbine-type flowmeter enables major advances to be made in the techniques of flow measurement and control. The de Havilland Pottermeter is the only flowmeter which offers all these features:

- **Accuracy to ±0·1% or better on repetition work, ±0·5% or better over a 20·1 range. Calibration remains constant for a variety of liquids over wide flow ranges.**
- Contains only one moving part—no thrust bearings—operates with a minimum of maintenance at high temperatures and pressures.
- No larger than the pipeline in which it is installed—may be mounted in any attitude.
- Can be supplied with indicating, recording and process control equipment—gives digital presentation of results.
- Can measure volumetric or mass flows.
- Models available to measure flows from 0·1 to 40,000 Imperial gallons per minute, at a wide range of operating pressures. Larger and smaller sizes made to order.
- Can measure flow of any liquid or gas, irrespective of its lubricating or non-lubricating properties, at temperatures ranging from -455°F to 1500°F.
- Manufactured as standard in stainless steel—can be made in any non-magnetic material.
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30 feet high and 25 tons in weight.

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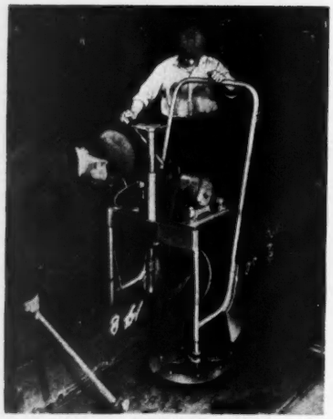
Another example of Pickering Welding Craftsmanship.



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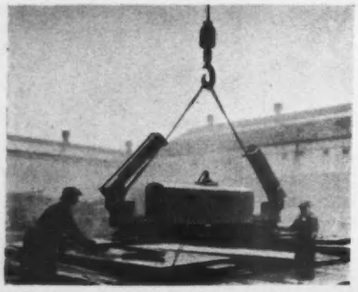
For the rapid Assembly of Fabricated Parts.



VACUUM LIFTING UNIT
For handling plates of varying lengths in lifts up to 6 tons.

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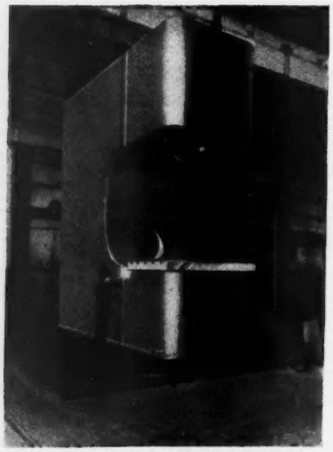
and the **JOB** *itself*



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Human Element

The Young Presidents Get There Sooner

UP TO a point they could be called the Have Everything Brigade.

The presidency of a company with not less than 50 employees and an annual gross income of not less than $1 million; these are the conditions of membership of the American Young Presidents Organisation.

Those are the conditions. What are the attributes?

The average age is 39, reward—$41,000 a year before tax, savings—$5,000 a year.

The same average Young President also works hard for his position. He spends ten hour a day at his work, the business trips take several weeks a year, but usually in his own plane. It is no good applying to join the YPO if you reach the presidency after the age of forty. And it is an interesting comparison with the big American corporation that in the Big League the chiefs, on average, arrive at the age of 52 and have only eight years to go before retirement.

The background of the Junior League leaders is mostly that of graduation with a year's postgraduate study. They are men (three only are women) from the Massachusetts Institute of Technology, the Harvard Business School, engineers, lawyers. More than three fifths of the concerns are in manufacturing, a third in service industries.

There are 1,500 Young Presidents, and there may be others so ultra-individualistic that they will not even join this body of run-your-own-show enthusiasts.

The organisation is ten years old this year. It would be interesting to know in another ten years whether the leaders have stayed in the (relatively) small time, or moved across the board to take a hand in the major corporations that dominate the American scene.

Smoothing the Way for the Passengers

Increasing technical improvement goes ahead on the permanent way. And with it some of the endearing characteristics of rail travel disappear. One of the most recent to go, but only from a limited part of the Western Region's track, has been the click of the wheels passing over the line joints.

The gaps in the rails, as every schoolboy train-spotter knows, allow for expansion from the summer's heat. But this is now found to be unnecessary. When sections of 60 ft rail have been welded to make up to a mile of continuous rail it has been found that the only part that expanded measurably was the last fifty yards.

This expansion of about the last fifty yards seems to be the same for one mile of welded rail or for ten.

The middle sections of the rail, prevented from expanding along their length, are too strongly held by the rest of the track to allow any movement out of alignment.

The staff of the Western Region have found that passengers who have grown accustomed to the clicks have been asking what is missing.

And it is not only the clicks that are going. Passengers on the new diesel service between Bedford and St. Pancras are being given more room by the removal of the seat arm rests. This not only gives more room—it removes, perhaps sadly, the warrior traveller's opportunity, faced by the well known unwillingness of three people sitting with the rests down to raise them, to exercise the strength of his glare and compel the rests to go up and make way for a fourth.

The High Powered World of US Management

At the top of the American professional tree sit the lawyers and the more outstanding architects. But climbing fast towards the highest branches are the management engineers.

At Balliol College, Oxford, last month, Mr. Ross Runnels, a consultant of the United States company Kurt Salmon Associates Incorporated, one of the better known consultants in the clothing and textile trades, recalled that a major factor in the improvement in the management engineer's position in the last twenty years had been the Association of Consulting Management Engineers.

Mr. Runnels, who has come to Britain to take up an appointment with the new Kurt Salmon and Production-Engineering Associates, was speaking at the annual conference of Production-Engineering Limited.

ACME, the United States equivalent of the British Management Consultants Association, has five main aims. They are to develop and enforce high standards of ethical professional conduct to make membership a mark of competence and reliability. To improve management consultation. To provide a better understanding of the management consultant's role. To further the interests of members by maintaining a central office. To gather information about consulting firms.

Protection

ACME keeps a close eye on Congress. On occasion it has alerted member firms to proposed laws that could have restricted the management consulting practice. In several cases this has led to organised efforts successfully protecting the consultants' interests.

While ACME has many more members than MCA, their share of the total national spending on management consulting is about half of the $400 million spent on management consulting in the USA in 1959. The big four of MCA accounted for almost 80 per cent of the equivalent British spending.

In the United States, as in Britain, the oldest and largest firms are those with a general approach to all industry. In addition, the American profession has many consultants who specialise in one industry—even one which advises solely on ranch management methods and another which counsels car dealers. Mr. Runnels referred to one firm, with a strong anti-Parkinson air, which from offices in New York, Chicago and San Francisco hurries to the aid of firms sinking in the slough of paperwork, reorganises, and drains the offending memoranda from the files.

Where MCA prohibits advertising, the Twelfth Article of the ACME code says: "We will not advertise our firm, practice or merits in a self-laudatory manner, or in any way which gives the impression of being undignified or unprofessional." In practice advertisements by ACME members often discuss management problems, the implication being obvious enough.

Where management consultants are discussed the subject of fees will not be far away. Mr. Runnels made two remarkably interesting points. He mentioned with admiration the august American consultancy firm (unnamed) who serve a distinguished cross-section of famous American corporations. Its invoices are submitted each month, without itemisation, simply stating the charge and explaining "for professional services." The rate of fees for consultants in the USA is enormously wide. It varies from $75 a day for junior consultants up to the occasional $500 a day for senior partners and those of outstanding ability.

Blue Streak Fiasco Leads to Dismissals

In the wake of the cancellation of Blue Streak come the sackings. The Sperry Gyroscope Company has given 200 skilled and semi-skilled men four weeks notice of dismissal. Sperry were responsible for the guidance system for Blue Streak and since the ending of the project have been making vigorous efforts to find alternative work, Government or private.

The sackings are due to become operative on 3 June at the company's Bracknell New Town, Berkshire, works. The men have marched round the town in protest at the situation but it is difficult to see what else the firm could have done.

The Sperry company has stated that whether there is to be further redundancy depends upon its success in finding alternative work. It is this possibility that more men will find themselves out of a job next month that is in the men's minds when they say they will go on demonstrating until the Government provides an alternative contract. Their plans include a march to No. 10 Downing Street.

The collapse of the case in favour of Blue Streak may have made its cancellation inevitable but it is doubly unfortunate that its effects should fall on Bracknell. The new towns need stability of employment to attract skilled workers and they need skilled workers to attract new industry.

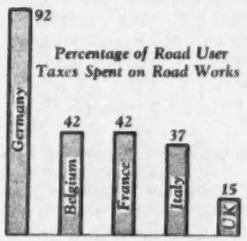
Marples the Anti-Motorist

Mr. Ernest Marples, the Minister of Transport, has an urban traffic planning policy which seems to be anti-motorist and completely negative.

This is not the view of some unfortunate private motorist still smarting at the thought of being tricked with a non-legal Pink Zone. It is part of the considered opinions of Mr. Brian Rootes, managing director of Rootes Limited, in his Wakefield Memorial lecture to the College of Aeronautical and Automobile Engineering.

Mr. Rootes did not confine his strictures to Mr. Marples alone. He thought the Government showed a complete lack of logic in blessing the industry's export plans, offering help in building new factories in special areas, and then handicapping the motor makers by failing to provide the roads to carry all the new vehicles.

The traffic is congested badly enough already with some 8·6 million licences in use. To Mr. Rootes' way of thought, Mr. Marples' forecast that there would



be 15 million vehicles on Britain's roads by 1975 was "dangerously conservative."

With Britain spending less on road construction and maintenance than almost any other European country, either per vehicle or proportionally to the national product, it was not very encouraging that while Germany goes ahead building 125 miles of *autobahnen* a year we are to spend only £66 million a year after 1961.

It appeared that we have not yet learned the lesson.

Mr. Rootes may have been covering familiar ground here but he struck out over unpopular country when he proposed that toll-roads on the American principle should be introduced. The extra financial burden on the road user, he thought, would be more than repaid by the safer conditions of travel.

Brasilia

That it took almost as long for us to build the Chiswick flyover as the Brazilians spent on putting up the centre of Brasilia, their new capital in the jungle, is one of those wounding, and true, observations from which there is no escape.

Greater urgency in the implementation of quite humble road repairs is certainly called for. It is not only the motorist waiting in the queue who doubts the wisdom of repair jobs being abandoned from five in the afternoon until eight o'clock the next morning.

It is easy to think for a moment of the road massacre and pick on some new alleged culprit, whether it be the fast driver, the driver of the old car, the new car, or most fashionable of late, the driver suffering from personal tensions.

Mr. Rootes may or may not be on good ground when he says that one way of improving road safety would be to institute a fresh test for every motorist over 65 and to hold a new test every two or three years from then on.

Chain Testers' Re-elect Chairman

Mr. T. W. McCullough, the Chief Inspector of Factories, was the principal guest at the luncheon which followed the recent annual general meeting of the Chain Testers' Association of Great Britain.

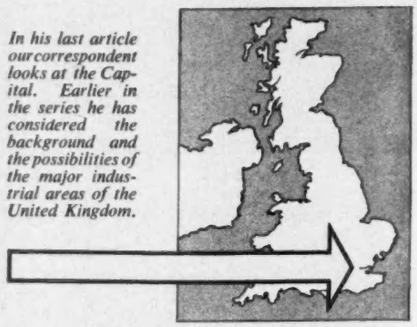
The chairman, Mr. Walter Brundrett, and the honorary secretary for the last 15 years, Mr. Harry A. Brown, were re-elected.

Engineering Growth in and around London

London. The nerve centre of British industry, it is also the work place of almost one in four of the country's labour force. Reconstruction and redevelopment are more important for the future than physical growth.

By H. J. Novy

In his last article our correspondent looks at the Capital. Earlier in the series he has considered the background and the possibilities of the major industrial areas of the United Kingdom.



THE industrial region of London and South East England has a population of 11 million with 5½ million workers, respectively 21 and 23 per cent of those who live and work in the United Kingdom. Some 8·2 million live in Greater London and 4·5 million work there. This is a tremendous concentration of industrial and commercial activity in a tiny area of our country, 700 square miles out of a total of 94,210. This is the dominant factor in the region's industrial situation, which vitally affects any future development. The major problem is not how to grow but how to prevent growth and how to introduce order in what is threatening to become chaos.

Ever since the Romans transformed the village of Londinium into a major trading centre between Europe and Britain in the second half of the 1st Century, and built the roads which made this possible, there has been uninterrupted growth until just before the Second World War when the population of Greater London reached 8·73 million. In the two decades which followed there has been a decline of half a million but no noticeable alleviation of congestion. Christopher Wren's brave attempt to replan the City after the Great Fire of 1666 was turned down by Charles II who could do little but bow to the powerful interests of the owners of the land. The second Great Fire, in 1941, was also followed by plans for reconstruction but neither the plan for the County of London or the plan for Greater London have yet achieved any major transformation although a great deal has, in fact, been accomplished. The Administrative County of London Development Plan, First Review 1960, indicates that the situation is changing and forecasts that the face of London will greatly alter during the next decade. Probably more radically than it has altered since the beginning of the century.

GROWTH OF INDUSTRY

At the time of the Industrial Revolution, London was ready to raise money to finance the factory system and so share in Britain's industrial expansion from the beginning. Entrepot trade began a period of rapid growth in the early 19th Century when both the West India and London Docks were completed. Expansion was exceedingly rapid; the population rose from 700,000 to 1¼ million between 1750 and 1820. Traffic handled by the Port of London trebled in 30 years. Manufacturing industry quickly became established—silk in Spitalfields, sugar-refining in Whitechapel, tanneries, dye works, iron foundries, breweries, glass works and many other industries along the banks of the Thames from Southwark to Vauxhall.

By the middle of the last century the population had increased to 2½ million. New roads and railways were built. By 1850 all the new main-line railway companies had lines with a terminus in central London. Thus the railways of England came to converge on London, just as the roads had done eighteen centuries before.

Henry Mayhew's "*London Labour and the Poor*" is a horrifying account of the misery which came along with the no less fantastic prosperity of these times. The population of the County of London reached its peak in the early years of this century and thereafter fell steadily, by almost half a million between 1910 and 1938 and by a further 800,000 in the two decades which followed. The population of Greater London continued to increase until 1939, when it reached 8·73 million; thereafter it declined very slowly and stood at 8·22 million in 1958.

The London region is the centre of gravity of British industry, the largest consuming area of manufactured goods and the largest exporting centre. When Ford selected Dagenham as a site, it was because they considered it ideally located for shipping British made cars to the Continent and for supplying the home market as well. Between the wars (1930-31) when the plant was put up at great cost on marshy ground, it was a courageous step since practically all components—which make up some 70 per cent of the ex-works cost of a car—had to be imported from the Midlands and South Wales.

The salient feature of employment in London and South East England is the very high proportion of people who work in offices, shops and services. The region accounts for 23 per cent of UK employment but for 49 per cent of the nation's labour force in insurance and banking, 29 per cent of those employed in public administration and 27 per cent of the country's professional people. In all, nearly 1·2 million of the insured population are classified under these three headings and about another 400,000 work in the offices of large firms who have their administration in London, most of them in the central area.

The London Plan published recently by the LCC shows that in 1951 nearly 30 per cent of all those employed in the County of London worked in offices and that 350,000 out of the 755,000 so employed worked in "metropolitan" offices, defined as "offices of organisations in manufacturing and other productive industry, or in trade and transport, that carry on their main operations outside London." They may be head offices, like those of the Coal Board and Associated Electrical Industries; or they may be sales offices, like those maintained by a host of provincial and foreign producers, merchants and shipping companies. In both cases the offices are detached from their associated factories, mines or depots and are located in London to take advantage of the great range of contacts possible in the commercial and administrative capital.

This emphasis on professional and administrative functions results in there being less manufacturing industry than is average for the country as a whole. In fact, London's manufacturing activities account for less than 20·8 per cent of UK employment in manufacturing industry. Within the group of manufacturing industries, which account for some 35 per cent of the total labour force of the London and South Eastern region (somewhat less of London's own labour force), metal using industries predominate and employ almost half the labour engaged in the manufacturing activities of the region.

There is a tendency for specialisation in light engineering and products which have a high value per pound.

Expansion in the London region since the war has been severely limited by the shortage of labour, although in total area of new buildings it rates second only to the Midlands, with 52·7 million sq. ft of new factories during the 14 years 1945-58. Almost half of this occurred in the engineering and other metal using industries. Significant expansion in other sectors took place in the manufacture of chemicals, when 8·2 million sq. ft were added—more than in any other region except the North East—and in industries already prominent in the London area, such as food and tobacco, paper and printing.

London's post-war expansion has undoubtedly been greatest in the administrative and professional activities which have prospered there for several centuries. Throughout the country there has been a tendency for the proportion of staff to operatives to rise and London has had more than its share of this increase. New techniques in management involving the use of more cost accounting, method and work study, operational research, the use of computers and other devices have tended to make London an even greater force in British industry. This trend is likely to continue.

It is the headquarters of the great banks and insurance companies and Europe's leading money market. It is in fact the mainspring of Britain's industrial machine. It is still the region where unemployment is lowest in the UK and where trade cycles appear to have little effect on the demand for labour. Last year unemployment averaged only 1·2 per cent of the insured population, compared with 2·3 for the UK as a whole, and there is no sign of any weakening in this situation.

ENGINEERING IN LONDON

The net output and employment of the region's engineering industries are shown in detail in the official Census of Production for 1954. The balance of these industries is unlikely to have altered radically since that date although some, such as the manufacture and repair of road vehicles, the manufacture of instruments and, to a lesser extent, electrical engineering and the manufacture of household appliances, have probably drawn even further ahead of the rest. Employment in manufacturing industry during the past five years increased to 1·94 million in 1958 but nearly all of this took place in factories outside the boundaries of the London County. Factory employment in the county decreased steadily during this period. In the London Plan, First Review 1960, the LCC point out that the number of operatives is continuing to fall by just under 1 per cent per annum.

Operatives employed in the production of metals and in engineering declined by 12 and 6 per cent respectively during the four years 1954-7 whereas the corresponding figures for the country as a whole were increases of 5 and 6 per cent. Only in the manufacture of vehicles did London show an increase greater than the national average, by 6 per cent compared with 1 per cent. The largest unit in the area by far is Ford at Dagenham with the body division, which they acquired in 1953.

Ford now employ some 54,000 people, altogether, about 40,000 of them in the London region. In 1954 they launched a £75 million modernisation and expansion programme which increased floor space by 50 per cent and doubled production capacity. The development at Dagenham has been considerable; in 1938 production totalled 87,000 units; during 1946, the first full year of peace, it amounted to 91,000 and by the end of 1959 it had grown to 469,000 of which 241,000 passenger cars and lorries were sent abroad.

The experience of Ford in the London area is probably unique, in the sense that they are more self-contained than most other motor manufacturers and make up the natural deficiencies of the region by producing much of their own raw materials and services. They make their own pig iron, their own castings—they have recently spent £7¼ million on the building of a new foundry on an adjoining 22-acre site where they employ 2,600 people—produce their own electricity, car bodies, and so on.

In the 14 years since the war, Ford increased their production floor space by 300 per cent and their labour force by 200 per cent but their output rose by 440 per cent.

The development of the aircraft industry in the London area began shortly after Sir Frederick Handley Page became interested in flying, as early as 1906. He founded his company in 1908 and erected the first British plant constructed exclusively for aircraft manufacture at Barking in the following year. The company's main works at Cricklewood and their aerodrome and assembly shops at Radlett remain an important unit in the industry. Other aircraft manufacturers in the region are de Havilland at Hatfield—now part of the Hawker Siddeley Group—and Vickers-Armstrongs (Aircraft) who, at Weybridge, own the largest structural machine shops in Europe.

This is the parent factory of their aircraft group, and the value of the machine tools installed there runs into millions of pounds. Currently in production is the new medium range turbo-prop Vanguard, and great hopes are entertained that it will be as successful an aircraft as the Viscount, of which over 400 have been sold. The V.C.10 long range transport is just coming into production and thus the Weybridge works is likely to be fully occupied for years ahead.

A striking feature of the engineering industry's development in the London region since the war has been the very large expansion of instrument manufacture. Leading firms such as Elliott Brothers (London), R. B. Pullin, Smiths Industrial Instruments, Venners, Fractional HP Motors, Evershed and Vignoles, and many others, are located in or near London. In 1958 the region accounted for nearly 47 per cent of all employment in the manufacture of precision instruments in Britain and nearly 2 million sq. ft of capacity have been added since the war.

Electrical engineering and the manufacture of radio and telecommunication equipment constituted the major engineering activity in the region. In 1954 the net output of those industries (including electric wires and cables) totalled £176 million and employment over 250,000. English Electric, General Electric, Edison Swan Electric Company, EMI, Enfield Cables, Hoover, Standard Telephones and Cables, Morphy-Richards, are only a few of the firms concerned. Many more lie close to the region's boundaries.

The attractions of London for firms making radio and television sets, electric vacuum cleaners, and other household appliances are obvious enough. They are similar to those which caused Ford to select Dagenham as a site and General Motors to come to the region in the first instance. For the manufacturers of instruments, however, the reasons are different, as they are for consulting engineers, designers and practically all those who are concerned with the production of complex plant and equipment.

MORE THAN ATTRACTIONS

The concentration of instrument manufacture in London is evidence of the Capital's appeal to those who are concerned with research and development.

The first, and perhaps the most important, factor in the choice of London is that it is a centre of engineering design. The Institutions—the Civil, Mechanical, Electrical, Chemical, Production—are all there, with public libraries, the stimulant of their meetings and all the facilities they provide for desk research and consultations. Practically every research association has its main offices in the capital, as well as the leading trade associations. In all these there are libraries and facilities for meeting others in the same or allied fields. The importance to the designer of being close to the Patent Office library, the British Standards Institution, the various sections of the Department of Scientific and Industrial Research is very real for progressive firms.

The second major attraction, for both the designer and the technical salesman, is the presence in London of the technical departments and buying offices of a large and increasing number of companies and public bodies. All the oil companies are centred there, most of them in the City and much the same applies to the large shipping companies, to BOAC and BEA, the Central Electricity Generating Board, the National Coal Board, the British Transport Commission and the engineering and buying organisations of the four regions of British Railways. London's own services, such as the Metropolitan Water Board, the area's Gas Boards, the London Electricity Board and the planning and design offices of large contractors and civil engineers—such as John Laing, Wimpey, Holland & Hannen and Cubitts, Taylor Woodrow and many more bodies and organisations which constitute essential ports of call for designers, application engineers and sales representatives of practically every firm.

This is why many of the process engineering consultants, such as the Lummus Company, Kellogg, Head Wrightson, and practically every civil engineering consultant in the country have their offices within two or three miles of the centre.

COMMUNICATION CENTRE

The third major attraction lies in the geographical situation of the region, at the end of practically every main road, rail line and air route in the country. The Romans laid the pattern, which was never disturbed but only strengthened during the Industrial Revolution and since. Companies with an export trade are almost compelled to maintain an office in London, for it is there that foreign visitors come and like to stay. The availability of first class port facilities, such as are provided by the Port of London Authority, are a big additional factor in the convenience of the location. The Thames wharves handle more cargo than any other in Europe, more than 50 million tons of inward and outward merchandise in a year.

The five-dock system stretching from the Tower of London to Tilbury has 155 berths of which 129 are deep sea berths. In addition, there are 80 berths of a specialised nature for timber, bananas, chilled meat, and bulk grain.

A very wide variety of industry has found it advantageous to set up plant along the river. The bulk of Britain's paper making capacity is situated on the Kent shore as are a number of cement works. Cement is the heaviest export from the Thames, about 1¼ million tons annually. On reclaimed marshland stand paint, varnish, lead, soap, and explosives factories. At Woolwich, Submarine Cables Limited are one of the country's main makers of submarine telephone cable.

Oil has come to play an important part in the trade of the Thames. There are three major oil refineries at Coryton, Shell Haven and the Isle of Grain. Shell Haven began operation in 1916 when a single distillation plant came into service on a 100 acre site. The plant now occupies 350 acres with a further 650 acres reserved for future development. The Isle of Grain refinery, opened a few years ago, had a capacity of 4½ million tons, which has now been raised to 7 million tons.

The Coryton refinery is smaller with an annual capacity of 2½ million tons, but as far as modern processing units are concerned it is comparable with its larger neighbour, and features a catalytic cracking plant for the production of premier grade petrol.

Few people realise that London University has an internal student population of more than 22,000, nearly 50 per cent more than the student population of Oxford and Cambridge put together. The Imperial College of Science and Technology has the largest output of engineers and scientists of any college in the country, and is being vastly expanded. Facilities for further education, at the Brixton Day College, the Battersea College of Technology, Chelsea College of Science and Technology, Northampton College of Advanced Technology, Finsbury and Barrett Street Technical College are all being greatly expanded.

London is on the whole well equipped for education, particularly higher education in sciences and engineering. It is yet another reason for the appeal it has to the makers of the more complex types of engineering equipment and the designers of control systems.

SHRINKING WORLD

London is still a focal point in the national and international scene; it is still a magnet for people of all types and nationalities. How long it will remain so must of course depend on how Britain fares in the growing competition to supply the world with the products it needs.

The importance of London will continue to increase as the world is made smaller by fast air travel. Large firms will find it more and more convenient to have a "strategic" sales force and team of application engineers conveniently located to reach any part of the world within a few hours. In the age of politico-economic rivalry between nations, there is a tendency for designs to replace arms as a means of international influence. London is already a major exporter of technical services and a major user of these services. It will become even more influential in the next two decades, particularly as there exist already all the facilities for the financing and insurance of almost any enterprise in the world.

London is unlikely to spread more. The planners foresee an expansion upwards, to buildings 300 ft high or more. Until the last decade few buildings exceeded 100 ft and four storeys, and it was widely believed that it was impossible to build higher due to the limited weight-bearing capacity of the subsoil and the difficulty to excavate deeply due to the effect on tube railways and other underground installations. Modern building techniques have removed some of these difficulties and there is little doubt that some of the congestion of today's layout will be relieved by this type of construction. More flats will be built in the centre, making it unnecessary for many people to travel so far to their work. The Barbican scheme in the City is an excellent example of what is intended.

New roads are planned to give better access to Britain's major cities. Parking problems are far from solved but a combination of meter controls and garages will clear the roads for traffic. The pity of it all is that the deterioration in the general situation is at a faster pace than the painstaking improvements now in hand. It is easy to clear the streets but it helps little those who have business to do and have to rely on car transport to do it. It is encouraging to read in the LCC's London Plan that they consider that "the road network must be made adequate to London's needs" and "a proper study of these needs should be undertaken immediately by a much expanded team of traffic engineers."

Another aspect of the greatest importance to London's space problems is the development of new towns. Migration from the County of London from 1931 to 1939 totalled 392,000; during the following 12 years, 781,000 left the county and another 241,000 from 1951 to 1958. Some of these have gone to the eight new towns built in the Home Counties. Their present total population is about 300,000 and growing steadily.

On the whole the future of London depends on her ability to reconstruct, redevelop, to introduce new methods and new techniques. The work is in hand within the council boundaries: much more will have to be started outside and there industry has a prime responsibility which cannot be shelved.

Forth Road Bridge Works

Erection of the first tower of the Forth road bridge is about to start. The foundations are ahead of schedule; the tower has been shop assembled.

THE Forth road bridge—the longest suspension bridge in Europe—is being built near to the world famous railway bridge which was completed 70 years ago. It will have a main span of 3,300 ft and two side spans of 1,340 ft each, the length between the abutments of the approach viaducts being 1½ miles. Some 39,000 tons of steelwork will be used in the bridge, together with 150,000 cu. yd of concrete. There will be twin roadways each 24 ft wide, two 9 ft cycle tracks and two 6 ft walkways, and the bridge will give a clearance of 150 ft above high water. Mott, Hay and Anderson, in conjunction with Freeman, Fox and Partners, are the consulting engineers, Sir Giles Gilbert Scott is the architect, and the bridge is being built by the ACD Bridge Company, the consortium formed by Sir William Arrol and Company Limited, Cleveland Bridge and Engineering Company Limited and Dorman Long (Bridge and Engineering) Limited. John Howard and Company Limited are the contractors for the foundations and anchorages for the main suspension span.

FOUNDATIONS

Contract No. 1, for the main suspension span foundations and anchorages, is now sufficiently advanced for a date in June, 1960, to be fixed for erecting the first section of the main tower base on the north pier.

In both main piers satisfactory rock strata have been reached, and the concrete pier footings have been completed. On the south side, sandstone rock at — 95 was reached by sinking caissons in free air. Advantage was taken of a 50 ft layer of dense boulder clay overlying the rock, a cofferdam being driven into the clay and de-watered. In order to obtain two large unobstructed areas in the cofferdam in which to build the caissons, it was made in the shape of a figure eight using circular walings. The two upper walings were made as a steel unit and floated into position. The lower waling is formed of concrete which was placed under water after the river bed had been excavated for a depth of 13 ft. This is shown on the drawing of the south pier cofferdam and caissons.

Inside the cofferdam two circular reinforced concrete caissons were built at — 36 and sunk 59 ft by excavating gravel and boulder clay. Water was easily controlled by three 6 in pumps. These caissons are now complete, and construction of the pier shaft is under way.

On the north side a submerged reef of basalt formed the foundations and here the cofferdam was formed of sheet piling sealed to the rock by a wall of concrete 10 ft thick and 9 ft high placed under water. This wall was anchored to the rock by 44 cables grouted into the rock and prestressed to 50 tons each. After prestressing, the cofferdam was pumped out and the hearting placed in the dry. Details of the north pier cofferdam are given in the second drawing. The pier base is now complete and the pier shaft is under construction.

ANCHORAGES AND TOWERS

For anchoring the suspension cables, tunnels have been driven at each side of the river. They are twin tunnels at 80 ft centres, driven at a slope of 30° to the horizontal into the solid rock, the cross-section of the tunnels increasing with depth. The shape and dimensions of the tunnels, as will be seen from the drawing, differ on the north and south sides.

On the south side the rock consists of shales with bands of sandstone, and here the tunnels are circular in cross-section, since it was found necessary to provide a continuous steel plate lining to the upper half of the section as the shale weathers rapidly on exposure. Each tunnel is filled with low heat concrete and contains 114 steel ducts of 4 in internal diameter. Into each duct is inserted an anchorage cable having a breaking load in excess of 380 tons. Six anchorage cables retain a rectangular steel slab at the mouth of the tunnels, to which are attached four high tensile bolts which carry the strand shoes of the main suspension cables. The anchorage cables are pre-tensioned to a load in excess of the maximum working load before the ducts are filled with cement grout. At present the position in the south tunnels is that 80 per cent of the concrete has been placed around the steel duct tubes, but the anchorage cables will not be inserted until the placing of all the concrete has ben completed.

On the north side the tunnel cross-section is rectangular, as the rock is intruded basalt, and roof support by roof bolting has proved adequate. To date, on this side, approximately 60 per cent of the concrete has been placed.

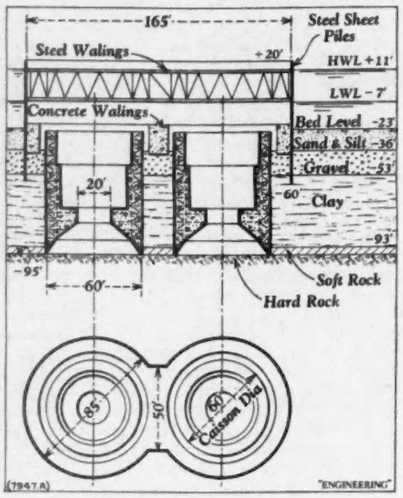
Twin towers form the shore ends of the suspension bridge itself, and carry saddles which deflect the main suspension cables from a nearly horizontal direction to an angle of 20° to the horizontal. The north tower is now complete and the south tower 75 per cent finished. They are cellular structures of reinforced concrete, and it is intended to prestress them to the underlying rock. Taking the foundations contract as a whole, John Howard and Company's work is about one month ahead of schedule.

The largest single steel components of the bridge, the main towers, are under construction in the Glasgow works of Sir William Arrol and Company. Each tower is of fabricated box section, built up from steel plates, and 505 ft high. Plate edges are planed ready for welding, and then assembled in a jig for welding into sections of up to 47 ft 6 in long and 34 tons maximum weight ready for road transport to the site and erection there on the prepared foundations. The sections will be lifted by a climbing crane and bolted together to form the tower.

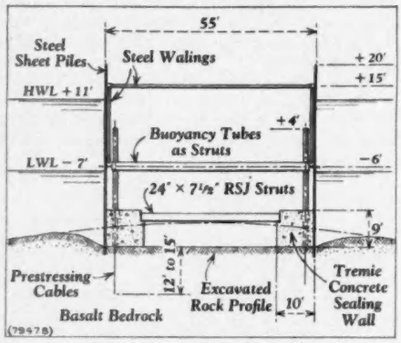
After welding, which is done by Fusarc machines, each section has its ends machined all over on a Kitchen and Wade horizontal boring and milling machine, to ensure square and accurate seating of one section on another, and the bolting ho'es are drilled. High tensile bolts will be used on assembly.

The sections, eleven of them forming a complete tower, have been trial-assembled in a horizontal position on the shop floor. In the illustration the first of the north towers is seen almost completed, with the second tower alongside it. In the case of the second tower the base has not yet been attached, and is seen standing in the erect position.

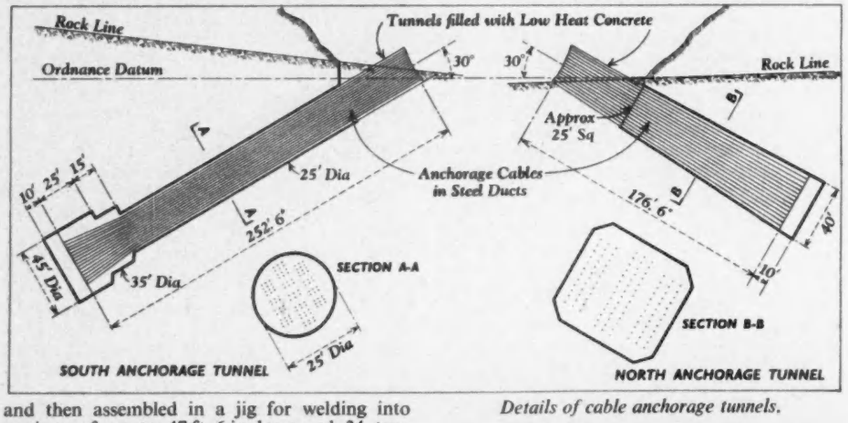
After shop erection, the towers are taken apart into their eleven sections and transported to a yard near the site where they will be metal sprayed prior to assembly.



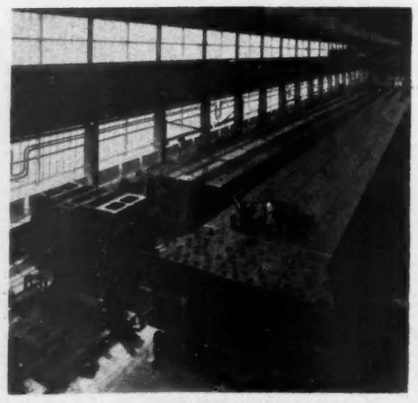
Construction of south pier.



Construction of north pier.



Details of cable anchorage tunnels.



Shop assembly of the first main tower.

640 MW Pumped Storage for Luxembourg

For 30 years, the Grand Duchy of Luxembourg has considered using the waters of the River Our as a source of electrical energy. The two stages of a pumped storage project at Vianden are well under way.

LUXEMBOURG's River Our, which winds through one of the most picturesque regions of that country, forms the present north-east frontier between the Grand Duchy and Germany. Its fast-flowing waters have eroded a deep gorge through a plateau which overlooks the river from a height of nearly 1,000 ft.

The idea of using this potential source of electrical energy dates back to 1931, when the Luxembourg Government sponsored the establishment of the Société Electrique de l'Our, and it was decided in due course that the most likely site for a large hydro-electric station lay in the region of Vianden-Bivals, on one of the slopes of St. Nicholas Mount. The map shows the position of the project in relation to the surrounding country.

A particular point of interest about the Vianden hydro-electric scheme is the extent to which it calls for underground works; indeed, the length of the galleries and the size of the powerhouse are unusual in Europe. The final capacity of 640 MW planned for this project will ensure that Vianden ranks among the largest pumped-storage hydro-electric developments in the world. In the attached view of the lower reservoir, the site of the power project is indicated by dotted lines while the barred area shows the level which the reservoir will ultimately attain.

A cross-section of the power house is shown in the illustration on this page. During the first phase of the project, only half the machine hall will be used. Here, there will be housed four groups of pumps, alternators and turbines, and the output at the end of the first phase is designed to be 320 MW. A further four groups of machinery will be added during the second phase; bringing the total power output to the required figure of 640 MW. Each of the groups comprises an 80,000 kW turbine, a 100,000 kW alternator and a 53,750 kW pump. The turbines will run free during pumping periods. The daily operating cycle will be 9 hours of pumping and 4 hours of generation.

Each of the generators is to be coupled to a transformer, which will step up the voltage to 220 kV. These transformers will be installed in a separate cavern, from which 220 kV cables are to be led to a substation and, subsequently, to the high-voltage line connecting the outer circuit to the grid of the Rheinisch-Westfälisches Elektrizitätswerk AG.

Work has been planned so that the operation of the plant installed during the first phase will not be disturbed by the construction of the second phase. The construction was begun in 1959. The first phase is planned to end in 1962. The operations began with the drilling of four entrance shafts: to the main entrance gallery, the gallery housing the main pressure shaft, the ventilation gallery and the transformer gallery. The rock through which these galleries are being drilled is mainly hard shale which does not require any props. Each gallery will be about 24 sq. yd in section.

As a result, the contractors were able to excavate the full surface of the ceiling without mishap and without any props. It is also planned to anchor the walls of the machine hall with special bolts fitted into holes having a diameter of 4 in and a depth of 16 yd. These holes are being drilled with Bison rock drills mounted on wagon drill chassis. The ceiling is to be faced with concrete.

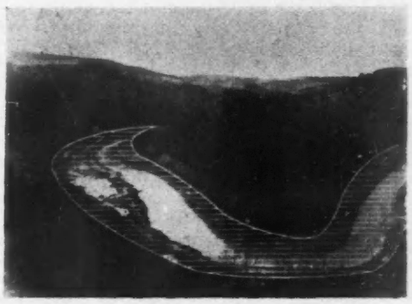
While this underground work has been going on, excavation of the basins for the upper and lower reservoirs has been proceeding. The surface rock of the upper basin is very brittle, and scrapers have been used to remove it. Any hard rock will be mined with the aid of wagon drills.

At the end of the first phase of the work, the upper dam will measure 1·3 miles (2·3 km) with an average height of 46 ft. The storage capacity (102,400,000 cu. ft) will be about doubled when the dam is extended in the second stage. Its upstream face will be lined with bituminous asphalt, as will the reservoir bed.

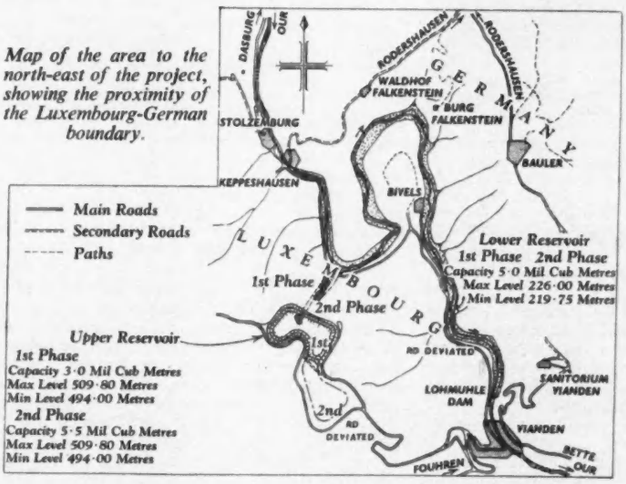
The contractors are also proceeding with the excavation of the lower reservoir and with the diversion of the road which runs alongside the present bed of the River Our. Construction of the 82 ft high dam has been started; its crest length will be 328 ft. At the foot of this dam a small compensation set will be installed to provide power to regulate the downstream flow.

When the second phase of the work is completed, the top reservoir will have been enlarged to hold 194·2 million cu. ft of water and, as already mentioned, the capacity of the complete project will be increased from 320 to 640 MW. Power produced at Vianden will be available to other nations through the European grid; indeed, it seems likely that Germany will be the largest consumer. It is possible that one or more of the units may be leased, to individual customers at an annual fee. During normal pumped storage operation, the Société Electrique de l'Our will buy energy from neighbouring networks, and there is likely to be a barter system whereby the Société will receive free power and will then return a proportion of the peak-load energy produced at Vianden, retaining the balance for sale.

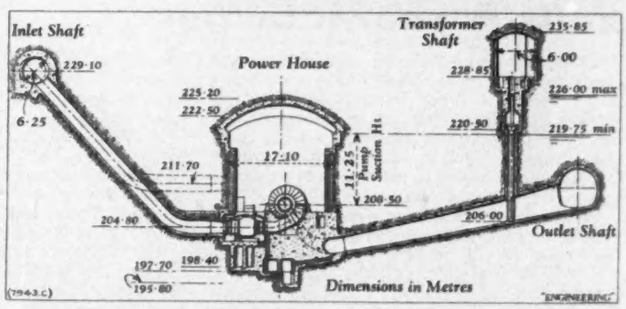
Site of the lower reservoir. The barred area indicates the level of the reservoir when completed and the dotted lines the power project.



Map of the area to the north-east of the project, showing the proximity of the Luxembourg-German boundary.



(Below) Cross-section of the powerhouse, including the inlet, outlet and transformer shafts.



Drilling is being carried out with Atlas Copco rock drills mounted on air legs and used in batteries of four per gallery. Two cubic metres (2·6 cu. yd) of rock are blasted by each charge and, in the main galleries, 9·1 to 10·5 cu. yd of rock are removed per day, though in the penstock shaft this figure is only 6·5 cu. yd a day.

At the present time, the entrance and ventilation shafts have been advanced to the level of the machine hall, and the main pressure shaft has reached the base of the penstock shaft which runs to the upper reservoir.

The machine hall is being excavated in a series of descending benches, the first three measuring 10, 18½ and 26½ ft in depth, respectively, and the bottom section being a special finishing job. As the first stage in the construction of the machine hall, the ventilation shaft was extended to the full length of that chamber. This has formed, in effect, a headshaft, which has been opened out; roof bolts have been used as a security measure while the work was in progress.

The work programme has been planned in two distinct parts and the present project, which constitutes the first part, comprises:

(1) A high-level reservoir with a water capacity of 102,400,000 cu. ft, created by means of a rock-fill dam crowning the summit of St. Nicholas Mount and provided with a bituminous lining.

(2) An inclined reinforced gallery or penstock, connecting the top reservoir to the machine hall, 1,680 ft long, having a fall of 91½ ft.

(3) An underground machine hall 984 ft long by 96 ft high by 56 ft wide.

(4)A tailrace tunnel from the machine hall to a lower reservoir, with a capacity of 176,500,000 cu. ft, formed by an enlargement of the bed of the Our; the water being retained by a dam built across the valley 1½ miles downstream, a few hundred yards from Vianden Bridge, at Lohmühle.

Lucas Hydrostatic Transmission

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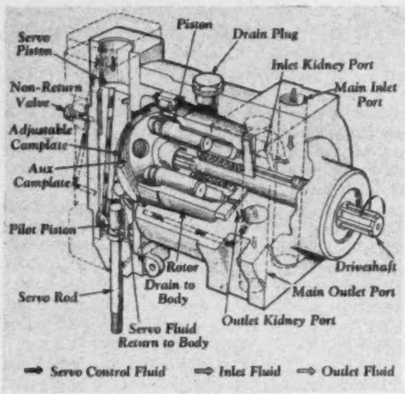
The pump is a variable swash plate unit which can be supplied with fluid by a boost pump or header tank. The driven rotor is a circular block containing four or more cylinders in which move the pistons. Each piston has at its base a ball joint attached to a slipper head which is retained in place by an auxiliary cam plate and rides on the face of the main adjustable cam plate. Angle of the cam plate is varied by a servo piston to determine the piston stroke and so, in conjunction with rotor speed, to vary the output of the pump.

The end face of the rotor revolves against a disc in which are cut two kidney shaped ports which admit oil to the cylinders as the pistons travel down and allow it to be expelled as the pistons rise. If the cam plate is moved over-centre or the direction of rotor rotation is reversed, the inlet and outlet ports exchange functions.

Hydraulic fluid, at pump outlet pressure, is circulated to the servo control mechanism through internal drillings in the pump body. An external control rod operates a small pilot piston. When this is moved inwards it uncovers a port which allows fluid to pass through an internal drilling from top to bottom of the servo piston. As the piston has two different diameters, that at the bottom being greater than at the top, the servo piston will move upwards, reducing the cam plate angle and reducing pump output.



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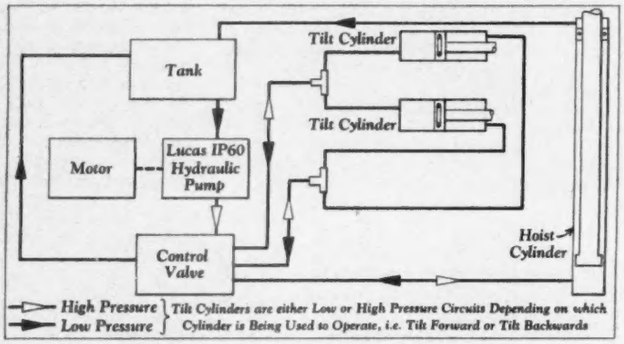
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Control Valve
Hoist Cylinder
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(Right) Circuit diagram of an application to a Coventry Climax fork truck.

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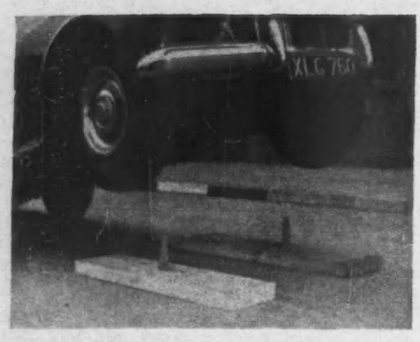
Recalling the remarkable history of the Dart prop-jet engine, the commentator says it was introduced into airline service in 1953 to power the Vickers Viscount. By the end of 1959, Dart engines had logged over 10 million hours on the air routes of six continents. When it was introduced the Dart was rated at 1,540 h.p.; by 1959 it was producing 2,600 h.p. and had by no means reached its full potential. During the same period the overhaul life had been increased from 400 hours to 2,200 hours, and the figure is still rising.



From the new film: drop test for a Rolls-Royce Silver Cloud II.

The motor-car division at Crewe is responsible for producing the commercial and military range of petrol engines as well as the cars. Shrewsbury is the location of the oil engine division. A range of standard components is the basis around which both types of engine are designed.

The company attach great importance to research and development. An advanced planning group is the starting point for the company's research activities. This group is concerned with visualising and developing entirely new concepts; preparing and designing projects to meet the conditions and requirements of 10 to 15 years hence; and providing a fundamental advance guard for the individual research departments of the various divisions.

Also depicted in the film is the Rolls-Royce work on the design and development of a nuclear reactor for marine application; work on rocket motors; the development of vertical take-off and landing aircraft engines; and the application of oil engines to locomotives and rail-cars.

" The Magic of a Name " is in colour and runs for 25½ minutes. It was made by R.H.R. Productions Limited, in association with the Film Producers Guild, and is available to recognised organisations through Sound-Services Limited, Wilton Crescent, London, SW19.

Special modifications are incorporated in the Phantom V limousine which Rolls-Royce have supplied to the Queen. The rear quarter windows and roof have been designed to give exceptionally clear visibility from both inside and outside the car. The roof is fitted with a glass centre and Perspex side panels, and the rear section of the roof is made in one piece of moulded Perspex. Fluorescent lighting is provided for illuminating the interior of the car.

The centre roof glass can be covered from inside the car by an electrically operated sliding panel. A folding metal exterior roof panel encloses the Perspex section at the rear when the car is not being used for ceremonial purposes, and is secured by locks with special safety escutcheons to prevent accidental opening. The cover, when removed, is stored in the luggage compartment.

As on all Phantom V limousines, fresh, warm or refrigerated air is provided through ducts.

For Her Majesty the Queen: a seven-passenger Phantom V limousine.

The Safest Industry

NUCLEAR engineering could be the most hazardous occupation in the world. Actually, the industry has an enviable safety record as a result of elaborate precautions and constant vigilance. Only a few serious accidents occurred during the 18 years since the first reactor started to operate, but they stirred up publicity out of all proportion to the damage caused. The accidents fall into three categories, inadvertant criticality, reactor accidents, and release of radioactive matter. The following is a survey of the most important accidents in the past.

Inadvertant Criticality

A reactor is not needed to obtain a chain reaction, it can happen in fuel storage rooms, in the pipes and vessels of a chemical plant or the retorts of a laboratory. The critical size of a water-moderated homogeneous core is a sphere with about 13 cm radius, containing less than 2 lb of uranium 235.

The design of nuclear chemical plant is a special art in itself, and the precautions against criticality often reach into the realm of the fantastic. Where work is not on a well regulated production basis and there is a need for variations in routine, the " infinite slab " method of criticality control may be used. (Atomic Review, 29 April '60.) Fissile material is only stored at one level to a depth less than required for criticality in an infinite slab, so that no matter how much material is brought together in that layer, a dangerous condition cannot arise. For regular production runs this method of control is wasteful of space. Instead, criticality calculations are performed for each vessel in the chemical process, and each group of vessels and pipes. The possibility that an unreflected system may inadvertantly receive a reflector as a result of flooding—or from the bodies of bystanders—is also considered.

Alternately, in batch processes it is possible to control criticality by limiting the amount of fissile material that is allowed to enter the system to subcritical proportions by careful accounting. In spite of such precautions, a few serious and several less serious criticality accidents occurred in American chemical plants.

Oak Ridge Excursion

On 16 June, 1958, supercriticality occurred in the Y-12 chemical plant of the Oak Ridge National Laboratory. Concentrated uranyl nitrate solution was being transferred from one part of the plant to another. Somewhere along the line a valve had been left open after a regular hydraulic test of the piping system, performed prior to the transfer of the solution. The valve was used to drain the water after the test into a 55 gallon steel drum. As the water did not normally contain fissile material, this drum was not required to have safe geometry. When the level in the drum reached about 9 in, the solution became critical while eight operators were standing in the vicinity. There was no flash or explosion, and material was not thrown out of the open tank. After a delay of about 3 to 5 seconds the radiation alarms sounded and the operators left the building. Power oscillations lasted for several minutes and were finally stopped by water flowing into the tank and diluting the solution. The eight operators were exposed to radiation between 30 and 461 rem (22 to 365 rad). No fatalities occurred and all persons were discharged from observation in six weeks.

Plutonium Flash at Los Alamos

Up to 1959 the Oak Ridge accident was the most serious in the Commission's history. Prior to the establishment of the Commission, two accidents had occurred in plants under the control of the war-time Manhattan Project, both of which had resulted in one fatality. Then on 30 December, 1958, another fatal accident occurred at the Los Alamos Scientific Laboratory. The plant was designed for batch handling of " lean residues " from the main plutonium recovery process. Criticality control in the plant was through the method of material control, although a change to continuous operation and geometric criticality control had been recommended and planned. In a vessel used for the solvent recovery in small batches, the operator, on his own authority, attempted to process several batches at once. Before the accident, the vessel held some 87 gallons of aqueous solution containing a small amount of plutonium (40 gm), and supporting an 8 in deep organic solvent layer (42 gallons) containing 3·27 kg of plutonium. The critical thickness for this solution was later estimated to be 8¼ in, leaving only a ¼ in margin for safety. In addition to plutonium in solution, some 60 grammes of plutonium solids were suspended both in the organic and the aqueous phases. Having filled the vessel, the operator switched on an electric stirrer located in the bottom of the vessel and immediately saw a strong flash and heard a muffled explosion. Reconstructing the event, it became apparent that action of the stirrer forced some aqueous solution up along the walls of

Not an accident, but Argonne's Borax-1 controlling supercriticality by the expulsion of water.

the vessel, displacing the organic phase. The small displacement was sufficient to increase the thickness of the layer to critical. Soon after the flash the separation between the organic and aqueous phases broke down and subcritical conditions were restored. The burst involved some 10^{17} fissions, killing the operator with a dose of 10,000 rem in 36 hours.

Power Excursion at the Boris Kidric Institute

In terms of human life the Vinca accident near Belgrade in October, 1958, could have been one of the most serious ever recorded. (Atomic Review, 6 March '59, 24 Oct. '58.) Although the excursion occurred with an operating reactor, the event must be classed as accidental criticality or supercriticality. The reactor was designed for zero-power operation but the accident was caused by a supercritical burst which left the reactor completely undamaged. Eight people were exposed to radiation which was first estimated to be around 680 rem. One died, five recovered after successful bone marrow transplantation, and two recovered without drastic surgery. The accident was possible as a result of faulty design in the safety system that permitted operation of the reactor with the safety instruments turned off. An uncontrolled rise of heavy water in the reactor tank resulted in supercriticality without the safety rods operating. In the absence of warning instruments, the operators noticed that something was wrong only from a smell of ozone.

Phantoms in Aid of Biology

Much information has been gathered from the few accidents in the past and successful methods of therapy are being developed to deal with over-exposure to ionising radiation. In particular the Vinca incident has yielded valuable information through the efforts of the IAEA and scientists from the Yugoslav, French, United States and United Kingdom atomic energy authorities. The combined team of experts, using instruments from France, dosimetry equipment from the United States, and heavy water from the United Kingdom, have reconstructed the accident and performed exact measurements to determine the relative amounts of gamma and neutron radiation received in various parts of the victims' bodies (Atomic Review, 19 Feb. '60). At a press conference held at the conclusion of the experiments Dr. Henry Jammet of the Curie foundation, where the bone marrow transplanations were performed, said that the experiments were designed to bridge the gap between the exact science of physics and the less exact science of biology. Biology could be raised to the level of exactness of physics only if the number of patients studied were comparable to the nuclear events at the disposal of the physicist, that is, 10^{10} or 10^{15} events per second instead of a few score per year. In the Vinca experiments transparent plastic dummies called phantoms were filled with a salt solution and the sodium 24 activation served as an indication of the dose received in various parts of the body. Results of the experiment will be published by the IAEA in a few weeks' time.

Reactor Accidents

While inadvertant criticiality is extremely dangerous from the point of view of health, the material damage tends to be insignificant. In contrast, reactor accidents may cause little harm to humans, but tend to result in considerable financial loss. Serious reactor accidents have been reported from Canada, the United States, France, the United Kingdom, and one from the Soviet Union. It must be noted that not all accidents are reported to the public, and Walter Zinn, formerly director of the Argonne National Laboratory of the USAEC, has stated publicly that even in the United States the policy is to withhold the information unless the release is justified. In the United Kingdom the most publicised reactor accident was the Windscale incident in October, 1957 (Atomic Review, 18 Oct. '57), with a loss of about £2 million for the damaged reactor, and another £1·5 million for the undamaged reactor which was shut down as a direct consequence. Some radioactivity spread over the fields around Windscale and milk valued at £60,000 had to be destroyed as a result. (Atomic Review, 21 Aug. '59).

Heavy-Water Reactors

Chalk River, one of the oldest reactor establishments in the world, has had two serious accidents in its long past. In 1952 the NRX reactor developed a leak, and in 1958 a fuel element failed in NRU. In both cases there was a considerable release of radioactivity and the reactor building and vicinity were contaminated, but unlike the Windscale piles, the Chalk River reactors could be restored to working order. Decontamination involved months of work inside the reactor building and the storage pit, where the faulty NRU fuel element was left uncooled and ignited as a result of decay heating. At the Saclay establishment of the French Atomic Energy Commission two heavy-water research reactors are in operation, EL-2 and EL-3. Both were involved in minor failures which are usually described as " incidents " resulting from fuel element ruptures. Some gaseous fission products were released to the atmosphere, but the ion exchange purification system for the heavy-water made it possible to put the reactors back into service in a relatively short time. Financial losses, as at Chalk River, were caused mainly by reactor down-time and lengthy decontamination of the reactor rooms. Minor fuel element failures are a feature of natural-uranium or low-enrichment reactors simply because there is so much fuel in the core. But in heavy-water reactors there is the added danger of uranium-water reactions which may lead to the explosive failure of the element and severe contamination of the core and water. In contrast to the low-enrichment or natural-fuel reactors NRX, NRU, EL-2 and EL-3, the enriched fuel DIDO-PLUTO reactors have given little trouble according to published data.

Breeder Reactor Meltdown

At the end of 1955 it was decided at Argonne to extend the usefulness of the experimental breeder reactor EBR-1, on which the scheduled programme had been completed, by performing a few power excursion experiments. The experiments involved operating the reactor without coolant for short periods of time and permitting the fuel temperature to rise to 500 or 600° C. The control system, which had not been designed for power excursion experiments, was left substantially unchanged, and the excursion was to be controlled by two persons, one watching the instruments, the other operating control rods. Owing to a misunderstanding the second, operator, when instructed to interrupt the excursion, instead of scramming the reactor attempted to use the fine control rods. After a two-second delay, both the first operator and the automatic devices initiated shut-down, but in that short period the fuel elements had melted. Small amounts of radioactivity escaped but otherwise there was little external

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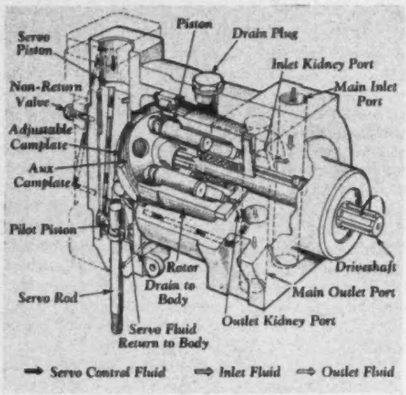

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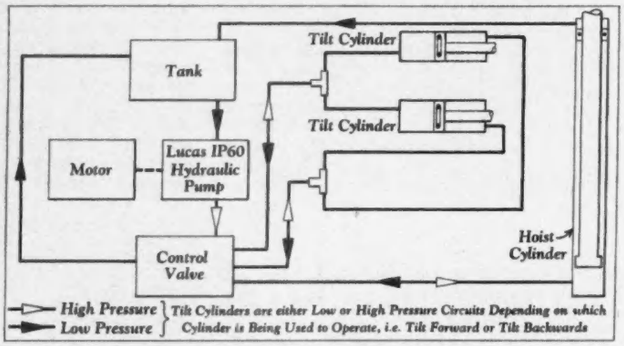
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Rolls-Royce Activities

The many-sidedness of engineering is well brought out in a film which has been produced for Rolls-Royce Limited. From research to after-sales service, the whole spectrum of engineering is illustrated by sequences showing the work of all the company's divisions—aero-engines, diesel engines, commercial and military petrol engines, motor-cars, nuclear work.

Recalling the remarkable history of the Dart prop-jet engine, the commentator says it was introduced into airline service in 1953 to power the Vickers Viscount. By the end of 1959, Dart engines had logged over 10 million hours on the air routes of six continents. When it was introduced the Dart was rated at 1,540 h.p.; by 1959 it was producing 2,600 h.p. and had by no means reached its full potential. During the same period the overhaul life had been increased from 400 hours to 2,200 hours, and the figure is still rising.

The motor-car division at Crewe is responsible for producing the commercial and military range of petrol engines as well as the cars. Shrewsbury is the location of the oil engine division. A range of standard components is the basis around which both types of engine are designed.

The company attach great importance to research and development. An advanced planning group is the starting point for the company's research activities. This group is concerned with visualising and developing entirely new concepts; preparing and designing projects to meet the conditions and requirements of 10 to 15 years hence; and providing a fundamental advance guard for the individual research departments of the various divisions.

Also depicted in the film is the Rolls-Royce work on the design and development of a nuclear reactor for marine application; work on rocket motors; the development of vertical take-off and landing aircraft engines; and the application of oil engines to locomotives and rail-cars.

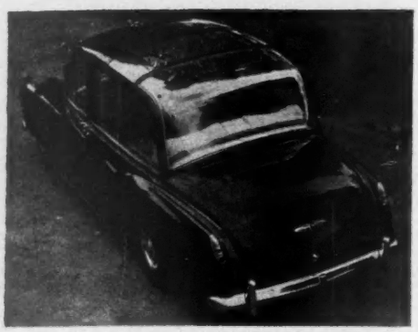
" The Magic of a Name " is in colour and runs for 25½ minutes. It was made by R.H.R. Productions Limited, in association with the Film Producers Guild, and is available to recognised organisations through Sound-Services Limited, Wilton Crescent, London, SW19.

Special modifications are incorporated in the Phantom V limousine which Rolls-Royce have supplied to the Queen. The rear quarter windows and roof have been designed to give exceptionally clear visibility from both inside and outside the car. The roof is fitted with a glass centre and Perspex side panels, and the rear section of the roof is made in one piece of moulded Perspex. Fluorescent lighting is provided for illuminating the interior of the car.

The centre roof glass can be covered from inside the car by an electrically operated sliding panel. A folding metal exterior roof panel encloses the Perspex section at the rear when the car is not being used for ceremonial purposes, and is secured by locks with special safety escutcheons to prevent accidental opening. The cover, when removed, is stored in the luggage compartment.

As on all Phantom V limousines, fresh, warm or refrigerated air is provided through ducts.

From the new film: drop test for a Rolls-Royce Silver Cloud II.



For Her Majesty the Queen: a seven-passenger Phantom V limousine.

The Safest Industry

NUCLEAR engineering could be the most hazardous occupation in the world. Actually, the industry has an enviable safety record as a result of elaborate precautions and constant vigilance. Only a few serious accidents occurred during the 18 years since the first reactor started to operate, but they stirred up publicity out of all proportion to the damage caused. The accidents fall into three categories, inadvertant criticality, reactor accidents, and release of radioactive matter. The following is a survey of the most important accidents in the past.

Inadvertant Criticality

A reactor is not needed to obtain a chain reaction, it can happen in fuel storage rooms, in the pipes and vessels of a chemical plant or the retorts of a laboratory. The critical size of a water-moderated homogeneous core is a sphere with about 13 cm radius, containing less than 2 lb of uranium 235.

The design of nuclear chemical plant is a special art in itself, and the precautions against criticality often reach into the realm of the fantastic. Where work is not on a well regulated production basis and there is a need for variations in routine, the " infinite slab " method of criticality control may be used. (Atomic Review, 29 April '60.) Fissile material is only stored at one level to a depth less than required for criticality in an infinite slab, so that no matter how much material is brought together in that layer, a dangerous condition cannot arise. For regular production runs this method of control is wasteful of space. Instead, criticality calculations are performed for each vessel in the chemical process, and each group of vessels and pipes. The possibility that an unreflected system may inadvertantly receive a reflector as a result of flooding—or from the bodies of bystanders—is also considered.

Alternately, in batch processes it is possible to control criticality by limiting the amount of fissile material that is allowed to enter the system to subcritical proportions by careful accounting. In spite of such precautions, a few serious and several less serious criticality accidents occurred in American chemical plants.

Oak Ridge Excursion

On 16 June, 1958, supercriticality occurred in the Y-12 chemical plant of the Oak Ridge National Laboratory. Concentrated uranyl nitrate solution was being transferred from one part of the plant to another. Somewhere along the line a valve had been left open after a regular hydraulic test of the piping system, performed prior to the transfer of the solution. The valve was used to drain the water after the test into a 55 gallon steel drum. As the water did not normally contain fissile material, this drum was not required to have safe geometry. When the level in the drum reached about 9 in, the solution became critical while eight operators were standing in the vicinity. There was no flash or explosion, and material was not thrown out of the open tank. After a delay of about 3 to 5 seconds the radiation alarms sounded and the operators left the building. Power oscillations lasted for several minutes and were finally stopped by water flowing into the tank and diluting the solution. The eight operators were exposed to radiation between 30 and 461 rem (22 to 365 rad). No fatalities occurred and all persons were discharged from observation in six weeks.

Plutonium Flash at Los Alamos

Up to 1959 the Oak Ridge accident was the most serious in the Commission's history. Prior to the establishment of the Commission, two accidents had occurred in plants under the control of the war-time Manhattan Project, both of which had resulted in one fatality. Then on 30 December, 1958, another fatal accident occurred at the Los Alamos Scientific Laboratory. The plant was designed for batch handling of " lean residues " from the main plutonium recovery process. Criticality control in the plant was through the method of material control, although a change to continuous operation and geometric criticality control had been recommended and planned. In a vessel used for the solvent recovery in small batches, the operator, on his own authority, attempted to process several batches at once. Before the accident, the vessel held some 87 gallons of aqueous solution containing a small amount of plutonium (40 gm), and supporting an 8 in deep organic solvent layer (42 gallons) containing 3·27 kg of plutonium. The critical thickness for this solution was later estimated to be 8¼ in, leaving only a ¼ in margin for safety. In addition to plutonium in solution, some 60 grammes of plutonium solids were suspended both in the organic and the aqueous phases. Having filled the vessel, the operator switched on an electric stirrer located in the bottom of the vessel and immediately saw a strong flash and heard a muffled explosion. Reconstructing the event, it became apparent that action of the stirrer forced some aqueous solution up along the walls of

Not an accident, but Argonne's Borax-1 controlling supercriticality by the expulsion of water.

the vessel, displacing the organic phase. The small displacement was sufficient to increase the thickness of the layer to critical. Soon after the flash the separation between the organic and aqueous phases broke down and subcritical conditions were restored. The burst involved some 10^{17} fissions, killing the operator with a dose of 10,000 rem in 36 hours.

Power Excursion at the Boris Kidric Institute

In terms of human life the Vinca accident near Belgrade in October, 1958, could have been one of the most serious ever recorded. (Atomic Review, 6 March '59, 24 Oct. '58.) Although the excursion occurred with an operating reactor, the event must be classed as accidental criticality or supercriticality. The reactor was designed for zero-power operation but the accident was caused by a supercritical burst which left the reactor completely undamaged. Eight people were exposed to radiation which was first estimated to be around 680 rem. One died, five recovered after successful bone marrow transplantation, and two recovered without drastic surgery. The accident was possible as a result of faulty design in the safety system that permitted operation of the reactor with the safety instruments turned off. An uncontrolled rise of heavy water in the reactor tank resulted in supercriticality without the safety rods operating. In the absence of warning instruments, the operators noticed that something was wrong only from a smell of ozone.

Phantoms in Aid of Biology

Much information has been gathered from the few accidents in the past and successful methods of therapy are being developed to deal with over-exposure to ionising radiation. In particular the Vinca incident has yielded valuable information through the efforts of the IAEA and scientists from the Yugoslav, French, United States and United Kingdom atomic energy authorities. The combined team of experts, using instruments from France, dosimetry equipment from the United States, and heavy water from the United Kingdom, have reconstructed the accident and performed exact measurements to determine the relative amounts of gamma and neutron radiation received in various parts of the victims' bodies (Atomic Review, 19 Feb. '60). At a press conference held at the conclusion of the experiments Dr. Henry Jammet of the Curie foundation, where the bone marrow transplanations were performed, said that the experiments were designed to bridge the gap between the exact science of physics and the less exact science of biology. Biology could be raised to the level of exactness of physics only if the number of patients studied were comparable to the nuclear events at the disposal of the physicist, that is, 10^{10} or 10^{15} events per second instead of a few score per year. In the Vinca experiments transparent plastic dummies called phantoms were filled with a salt solution and the sodium 24 activation served as an indication of the dose received in various parts of the body. Results of the experiment will be published by the IAEA in a few weeks' time.

Reactor Accidents

While inadvertant criticiality is extremely dangerous from the point of view of health, the material damage tends to be insignificant. In contrast, reactor accidents may cause little harm to humans, but tend to result in considerable financial loss. Serious reactor accidents have been reported from Canada, the United States, France, the United Kingdom, and one from the Soviet Union. It must be noted that not all accidents are reported to the public, and Walter Zinn, formerly director of the Argonne National Laboratory of the USAEC, has stated publicly that even in the United States the policy is to withhold the information unless the release is justified. In the United Kingdom the most publicised reactor accident was the Windscale incident in October, 1957 (Atomic Review, 18 Oct. '57), with a loss of about £2 million for the damaged reactor, and another £1·5 million for the undamaged reactor which was shut down as a direct consequence. Some radioactivity spread over the fields around Windscale and milk valued at £60,000 had to be destroyed as a result. (Atomic Review, 21 Aug. '59).

Heavy-Water Reactors

Chalk River, one of the oldest reactor establishments in the world, has had two serious accidents in its long past. In 1952 the NRX reactor developed a leak, and in 1958 a fuel element failed in NRU. In both cases there was a considerable release of radioactivity and the reactor building and vicinity were contaminated, but unlike the Windscale piles, the Chalk River reactors could be restored to working order. Decontamination involved months of work inside the reactor building and the storage pit, where the faulty NRU fuel element was left uncooled and ignited as a result of decay heating. At the Saclay establishment of the French Atomic Energy Commission two heavy-water research reactors are in operation, EL-2 and EL-3. Both were involved in minor failures which are usually described as " incidents " resulting from fuel element ruptures. Some gaseous fission products were released to the atmosphere, but the ion exchange purification system for the heavy-water made it possible to put the reactors back into service in a relatively short time. Financial losses, as at Chalk River, were caused mainly by reactor down-time and lengthy decontamination of the reactor rooms. Minor fuel element failures are a feature of natural-uranium or low-enrichment reactors simply because there is so much fuel in the core. But in heavy-water reactors there is the added danger of uranium-water reactions which may lead to the explosive failure of the element and severe contamination of the core and water. In contrast to the low-enrichment or natural-fuel reactors NRX, NRU, EL-2 and EL-3, the enriched fuel DIDO-PLUTO reactors have given little trouble according to published data.

Breeder Reactor Meltdown

At the end of 1955 it was decided at Argonne to extend the usefulness of the experimental breeder reactor EBR-1, on which the scheduled programme had been completed, by performing a few power excursion experiments. The experiments involved operating the reactor without coolant for short periods of time and permitting the fuel temperature to rise to 500 or 600° C. The control system, which had not been designed for power excursion experiments, was left substantially unchanged, and the excursion was to be controlled by two persons, one watching the instruments, the other operating control rods. Owing to a misunderstanding the second, operator, when instructed to interrupt the excursion, instead of scramming the reactor attempted to use the fine control rods. After a two-second delay, both the first operator and the automatic devices initiated shut-down, but in that short period the fuel elements had melted. Small amounts of radioactivity escaped but otherwise there was little external

indication that anything went wrong and the reactor had been wrecked.

From Individual to Population Hazard

Release of radioactive matter constitutes a third form of hazard. Instead of endangering individuals as supercriticality does, or ruining reactors and buildings, the widespread release of radioactivity can have long-term genetic effects which would not become immediately noticeable. Apart from the explosion of nuclear devices and the controlled discharge of radioactive wastes, there has so far been no major contamination affecting populations although some radioactivity spread beyond the confines of the reactor installation in both the Windscale and the NRX incidents. On a smaller scale several accidents in chemical plants have resulted in the scattering of radioactive matter, and dozens of minor accidents must have gone unreported. One of the costliest occurred at Oak Ridge.

Explosion Scatters Plutonium in Chemical Plant

Equipment valued at $10,000 has been lost, $300,000 written off for decontamination, and production halted in three plants as a result of a chemical explosion in one of the hot cells of the Thorex pilot plant at the Oak Ridge National Laboratory, USAEC. The cell was used for processing irradiated fuel in the plutonium recovery scheme and the accident occurred after the completion of a production run. The cell was being cleaned with a chemical solvent which exploded for unknown reasons, blowing the cell door open and scattering radioactive materials over a four acre area. Approximately 600 milligram of plutonium was scattered in the immediate vicinity of the hot cell, which remains inaccessible for decontamination owing to the high level of gamma radiation. The accident occurred on 30 November, and decontamination took two and a half months. About 100 yards of roadway had to be replaced; the roof of a building had to be sprayed with tar; walls cleaned and repainted; and a ¼ acre tract returfed. An extensive sampling programme was undertaken to determine the radiation exposure of workers employed in the plant and those performing decontamination. Of about 250 persons involved, nine showed "sufficient radiation to require additional study." It is estimated that the body burden of plutonium in the nine individuals has risen to approximately 1 per cent of the maximum permissible. Pending an investigation into the causes of the accident and a review of the operating procedures and safety devices employed, three chemical plants of the laboratory will be shut down. The plants affected are the Thorex pilot plant, the metal recovery plant and the multicurie fission-products pilot plant. The latter facilities were not involved in the Thorex accident.

Remote Control Decontamination Sweeper

A motorised sweeper guided by radio signals has been developed by the US Air Force to facilitate decontamination of airports from the effects of fall out. Although designed for emergencies, the machine can also be used for the everyday cleaning of the runways. Built by the G. H. Tennant Company of Minneapolis, the machine can be operated from a remote control panel that duplicates the layout of the driver's cockpit. To obtain the driver's view in the protected shelter, rotateable television cameras are mounted on the sweeper. The remote operator can steer, shift gears, alter speed, apply the brakes, empty the sweeper's hopper, and direct the television cameras to aid visual inspection of contaminated damage areas. (*Journal of the Franklin Institute*, vol. 269, No. 3, p. 251.)

Notes and News

Extension of Amersham Radiochemical Centre

As a result of continued increase in the sale of radioactive isotopes and compounds (Atomic Review, 19 Feb. '60), two new laboratories have been added to the Amersham radio-chemical centre of the UKAEA. The laboratories are designed to fill the demand for radioactive tracer compounds, used on a rapidly increasing scale in many branches of research, and to provide natural radioactive elements, in particular radium, for biology and medicine. The tracer compounds are characterised by low toxicity and weak radioactivity, while the radium group of elements is highly toxic and active, and is extremely difficult to handle on a commercial basis. Owing to the difference in techniques and properties, two separate laboratories were constructed with shared services to house the Organic and Natural Radioelement departments. Most of the tracer compounds are based on the radioactive isotopes carbon 14 and tritium, obtained from the Authority's reactors. In the Organic laboratories the radioactive carbon isotope is incorporated in a range of compounds which has increased from 5 in 1949 to over 200 at present. Tritium has a shorter history than carbon 14 with production at Amersham not starting till 1959, but about 50 compounds are now available. In spite of the wide availability of artificial radioactive isotopes, the use of natural radium and allied elements has continued to increase. The Natural Radioelements department performs the chemical refining of radium and manufactures radium appliances for therapeutic use. The nation's stock of medical radium, comprising over 25,000 needles and tubes, is also maintained at Amersham. Other uses of the radium family of compounds are in neutron sources for well-logging and neutron experiments.

Airship Turbines Use Chemical or Nuclear Fuel

Using a small nuclear reactor to provide sufficient power to hold station against strong headwinds, airships could be easily built today to replace fixed northern radar stations. A design developed by the Goodyear Aircraft Company would use a 7 MW(t) compact reactor operating through Brayton cycle turboprop engines. The engines would also be equipped with conventional combustion chambers so that for greater power output or landing and take-off, chemical fuels could be used. The ability to convert to chemical power would permit the use of very thin shielding if advantage is taken of the large separation between crew and reactor possible on an airship. The separation on a 4 to 4½ million cu. ft airship would be between 150 to 200 ft. In operation, the ship would take off on chemical fuel, then start up the reactor to save fuel. When reaching the picket station the chemical fuel would be shut off and the ship would maintain its position and derive electrical power from the reactor. Prior to landing, the reactor would be shut down for 10 hours to allow for fission product decay and the airship would land using chemical fuel. Radiation control and fuel range are shown in Figs. 1 and 2. (Leo Jurich, "The Nuclear Powered Airship," paper presented at the SAE National Aeronautic Meeting, New York April, 1960.)

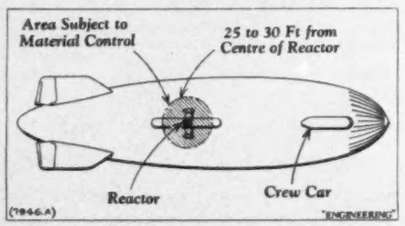


Fig. 1 Extent of radiation effects from a 7 MW(t) reactor using minimum shielding.

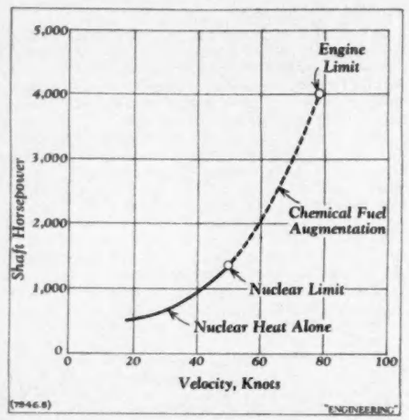


Fig. 2 Power schedule for airship using combined nuclear and chemical propulsion.

Japanese Experience in Gamma Irradiation

Since 1957 the Japanese Institute for Chemical Research at Kyoto University has been operating three gamma-ray irradiation facilities with source strength of 2,000, 200 and 10 curies of cobalt 60. The experience gathered during a one-year period up to June, 1959, has been published in a special supplement to the *Bulletin* of the Institute containing 23 papers. The 2 kilocurie source is used in component testing and special applications, the 200 curie facility for high-polymer chemistry and the smallest source for ceramic research. (*Bulletin of the Institute for Chemical Research*, Kyoto University, vol. 37, No. 5-6, December, 1959.)

New Director General at CERN

Following the death of Professor C. J. Bakker, the Dutch director-general of the CERN high energy laboratories, Mr. J. B. Adams has been appointed to head the international organisation. Mr. Adams, formerly of Harwell, had been director of the CERN proton synchrotron division prior to his new appointment.

Sir Leonard Owen's Hint

Voicing the opinion that while the capital cost of conventional stations is unlikely to be reduced much further, nuclear station costs are still coming down, Sir Leonard Owen has joined the battle over Britain's power policy. The statement was made in an address to the North Western Fuel Luncheon Club in April.

Ultrasonic Level Gauge for Mixer-Settlers

To determine the level of the interface between the aqueous and organic phases in a mixer-settler tank of a solvent extraction process, the UKAEA proposes to use an ultrasonic detector. Signals from one or more ultrasonic transducers are reflected from the interface and can be displayed on a cathode-ray tube. The level indication is free from interference caused by scum and sediment.

Culham Laboratories for Thermonuclear Research

Construction of the new Culham laboratories of the UKAEA to house the intermediate current stability experiment (ICSE) and other thermonuclear and plasma physics projects is to start immediately. The laboratory will be completed in about two years.

Manoeuvring and Reactivity

The build up of neutron-absorbing fission products in a reactor tends to inhibit reactivity, so that after shut-down or low-power operation during manoeuvring, restarting becomes difficult. Thus some means of dealing with fission products, and particularly xenon, is especially important in marine reactor plants. The mechanism by which xenon builds up and absorbs neutrons in a reactor following a reduction in power or total shut-down is now well understood and predictable. Short of adopting a reactor design incorporating facilities for the continuous removal of fission products, the build-up to saturation level during operation is inevitable and must be compensated for by the investment of an appropriate amount of excess reactivity. The build-up effect following a reduction of power or total shut-down creates a special problem. Sufficient excess reactivity may be built into the reactor to override the build-up effect. This is not only expensive in fuel, but for it to be effective the outspeed of the control rods to release the reactivity when required must be high, which may affect reactor safety. If on the other hand override is not provided, unless the reactor can be restarted within a short time, there is no prospect of making the reactor critical again for some 36 hours.

Reactor Notes

Savannah Costs: Initial fuel costs in the nuclear merchant ship NS Savannah are estimated to be about 6 mills per shaft horsepower hour. A 40 per cent reduction is thought to be the most that can be expected for the design, said R. E. Wilson, USAEC commissioner, at the Atomic Industrial Forum conference, April 30.

Big Brother for Shippingport: Construction may start on a record size 360 MW(e) single reactor station next year for the Southern California Edison Company. Westinghouse would supply the nuclear and electro-mechanical equipment with Bechtel Corporation as architect-engineers. Features of the plant are: cost $70 million, pressure 2,000 lb per sq. in, reactor vessel weight 300 tons, uranium oxide fuel, four year construction time.

Organic Modifications: At a cost of over one million dollars the organic moderated reactor experiment (OMRE) of Atomics International will be modified to extend the reactor's usefulness. Fluor Corporation will be in charge of the work, which will include construction of a new reactor building, laboratories, repair facilities and extensive modifications to the utility systems.

Sale of Heavy Water: In 1959 the USAEC exported approximately 100 tons of heavy water at a value of over $22 million.

The

'Engineering' Appointments

Section

PUBLIC APPOINTMENTS

CENTRAL ELECTRICITY GENERATING BOARD

TRANSMISSION DEPARTMENT

Headquarters, London, S.E.1.

CIVIL ENGINEER (TRANSMISSION)

required in the **Civil Engineering Sub-Branch of the Transmission Construction Branch.**

Candidates must be Corporate Members of one of the recognised Engineering Institutions by examination and/or hold a University Degree in Civil Engineering and have a wide experience of general Civil Engineering work.

The successful applicant will be in charge of the Civil Engineering Sub-Branch which is responsible for all aspects of the design and construction by contract of the civil engineering and building work required in connection with the establishment or extension of high voltage sub-stations.

Salary within the range £2,820-£3,020 p.a.

Applications, stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 7th June. Envelopes should be marked " Confidential Ref. ENG./186." C 106

MECHANICAL ENGINEER

ROYAL MINT has vacancy for a MECHANICAL ENGINEER. Pensionable post. Degree in mechanical engineering or equivalent qualification necessary.—Apply in writing for particulars to ESTABLISHMENT OFFICER, ROYAL MINT, LONDON, E.C.3. C 98

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

AIR MINISTRY require ASSISTANT MECHANICAL and ELECTRICAL ENGINEERS for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to maximum of £1260 with increase for London and slight decrease for country districts. Appointments non-pensionable but long term. Promotion prospects. 5-day week with 4 weeks 2 days leave a year initially. Special allowance in addition to salary during overseas service. Qualifications and experience:

(i) (a) University degree or equivalent diploma in electrical and/or mechanical engineering with at least 2 years' apprenticeship;

or (b) Graduate or corporate member of I.E.E. with at least 3 years' apprenticeship;

or (c) Graduate or corporate member of I.Mech.E., appreciable electrical engineering experience with at least 3 years' apprenticeship;

and (ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45. Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26 KING STREET, LONDON, S.W.1, quoting D 158/0A. C 99

SURREY EDUCATION COMMITTEE

WIMBLEDON TECHNICAL COLLEGE, GLADSTONE ROAD, S.W.19.

GRADE " B " ASSISTANT required SEPTEMBER, 1960, to teach MACHINE SHOP ENGINEERING to final level in C & G Courses. Applicants should hold H.N.C. in Mechanical or Production Engineering, or equivalent, and must have had good industrial workshop experience. Salary, Burnham Scale, £700-£1150, plus London Allowance.

Application form and further particulars obtainable from PRINCIPAL, to be returned within two weeks of date of advertisement. C 96

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

Applications are invited for the post of MECHANICAL RESEARCH ENGINEER in connection with a large research project on the automatic control of machine tools. Candidates should be graduates or should hold a Higher National Certificate; some knowledge and experience in hydraulics, control engineering or machine tools would be an advantage. Salary in the range £750-£900 per annum.

Applications should be addressed, as soon as possible, to the REGISTRAR, THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY, SACKVILLE STREET, MANCHESTER, 1, from whom further information may be obtained. C 67

STAFFORDSHIRE COUNTY COUNCIL

EDUCATION COMMITTEE

CANNOCK CHASE MINING AND TECHNICAL COLLEGE

Principal: C. D. GRAHAM, B.Sc.(Eng.)(Hons.), M.I.Mech.E., A.F.R.Ae.S.

Applications are invited from suitably qualified persons for the following teaching posts which have arisen through the growth of the College and promotion of existing staff.

ENGINEERING DEPARTMENT

One SENIOR LECTURER to teach Mathematics to Advanced classes and to advise on the teaching of Mathematics throughout the College. Ability to offer Electrical and/or Physics would be advantageous. Applicants should have a good degree and previous teaching experience.

Two ASSISTANTS GRADE "A" to teach one or more of the following subjects: Engineering Science and Engineering Drawing to National Certificate students and Science, Calculations, and Drawing to Craft students. Industrial and previous teaching experience are desirable.

MINING DEPARTMENT

One GRADE " B " ASSISTANT to teach Mining Technology, Mining Science, and Geology to National Certificate students. A degree and teaching experience are desirable.

Salaries in accordance with the Burnham (Technical) Scale, i.e.:—

Senior Lecturer: £1550 by £50 to £1750.
Grade " B " Assistants: £700 by £27 10s. to £1150.
Grade "A" Assistants (men): £520 by £27 10s. to £1000.

Forms of Application, returnable by 25th May, 1960, together with further particulars relating to the appointments may be obtained from the DIRECTOR OF EDUCATION (STAFFING DEPARTMENT), COUNTY EDUCATION OFFICE, STAFFORD, on receipt of a stamped addressed foolscap envelope. Candidates should state for which post forms are required. C 42

COLLEGE OF ADVANCED TECHNOLOGY, BIRMINGHAM

Applications are invited for the following posts:—

PRINCIPAL LECTURERS IN MECHANICAL ENGINEERING

Candidates should be qualified to teach up to post-graduate level and to conduct project, research and development work in one of the following:—

i) **Applied Thermodynamics**
ii) **Mechanics of Fluids**
iii) **Strength of Materials**
iv) **Machine Design**

Industrial, research and teaching experience are desirable. Successful candidates will be expected to assist (*a*) in the development and co-ordinating of laboratory work; (*b*) with a limited amount of administrative work, and will be encouraged to develop industrial contacts.

PRINCIPAL LECTURERS in MACHINE TOOLS AND DESIGN METROLOGY AND QUALITY CONTROL

Applicants should have good academic and professional qualifications and industrial experience with technical responsibility in the relevant subjects, ability to develop and co-ordinate the teaching and laboratory work, organise special advanced courses and maintain liaison with industry. Knowledge and experience of recent developments will be highly acceptable.

Salary Scale: (Men) £1750 - £1900

Further particulars and forms of application from the

BURSAR, COLLEGE OF ADVANCED TECHNOLOGY, GOSTA GREEN, BIRMINGHAM, 4.

Applications to be received within 14 days of this advertisement. Please quote ref. 'K'.

K. R. PILLING, Clerk to the Governors.

C 75

BRISTOL SIDDELEY ENGINES

An interesting and responsible vacancy exists at BRISTOL SIDDELEY ENGINES LIMITED, COVENTRY DIVISION for a

WELDING ENGINEER

Applicants must be fully experienced in all types of welding to Lloyd's standard and also all classes of welding techniques, including Resistance, Electric Arc, Argon Arc and Gas to A.I.D. standards.

A full knowledge of welding theory is essential and an ability to work in close liaison with the Design Staff will be necessary.

The appointment will carry Senior Staff Status together with a salary commensurate with the ability, experience, qualifications and age of the successful candidate.

Please apply, in strict confidence, giving full details, to: The Personnel Manager, Bristol Siddeley Engines Limited, Coventry Division, PO Box 17, Coventry.

C94

NORTHAMPTON COLLEGE OF ADVANCED TECHNOLOGY

ST. JOHN STREET, LONDON, E.C.1

requires

LECTURERS

and

SENIOR LECTURERS

in

MECHANICAL ENGINEERING

These vacancies arise from the continued expansion of the College in Degree, Diploma in Technology and Post-Graduate Studies.

Salary scales: Lecturer £1408 rising to £1601
Senior Lecturer: £1588 rising to £1801.

Particulars and forms of application are available from the SECRETARY, to whom applications should be sent by 5th JUNE.

C 69

THE GENERAL ELECTRIC COMPANY LIMITED

ATOMIC ENERGY DIVISION

Opportunities exist for young mechanical engineers to work in a development laboratory handling the mechanical engineering problems that arise in the design and construction of nuclear power stations.

DEVELOPMENT ENGINEERS

qualifications required are a mechanical engineering apprenticeship and a degree or equivalent. Some drawing office experience would be an advantage.

ASSISTANT DEVELOPMENT ENGINEERS

qualifications required are a mechanical engineering apprenticeship and H.N.C. or be studying for H.N.C. Drawing office experience would be an advantage, but successful candidates without this can spend an initial period on the board.

Applications should be made to **PERSONNEL MANAGER (DWB/20), THE GENERAL ELECTRIC COMPANY LIMITED, ERITH, KENT.**

C 89

UNIVERSITY OF EDINBURGH

DEPARTMENT OF ENGINEERING

Applications are invited for the post of LECTURER in the DEPARTMENT OF ENGINEERING. The Salary Scale is £1050 to £1850 per annum, with placement according to qualifications and experience, and with superannuation benefit and family allowance where applicable.

Candidates should possess an Honours Degree in Engineering, together with teaching, industrial or research experience, particularly in the field of Heat Engines and Thermodynamics.

The successful candidate will be expected to take up duty on 1st OCTOBER, 1960.

Further particulars may be obtained from the undersigned, with whom applications (six copies), giving the names of two referees, should be lodged not later than 11th JUNE, 1960.

CHARLES H. STEWART,
Secretary to the University.

C 84

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the CHAIR OF MECHANICAL ENGINEERING and Headship of the Department. Salary, £3100 per annum, with membership of the Universities' Superannuation Scheme and children's allowances. Conditions of Appointment and Form of Application, which should be returned by 30th JUNE, 1960, from the REGISTRAR.

C 91

UNIVERSITY OF ABERDEEN

and

ROBERT GORDON'S COLLEGES

Applications are invited for the following posts:—

UNIVERSITY LECTURER IN MECHANICAL ENGINEERING. Candidates should have special qualifications in applied thermodynamics. An interest in Heat Transfer apparatus, or in the special problems associated with the generation of Heat and Power from Nuclear Reactors, and some industrial or research experience would be an advantage.

UNIVERSITY LECTURER IN ELECTRICAL ENGINEERING.

Excellent facilities for research or advanced studies. University Regulations permit members of teaching staff to read for degree of Ph.D. by research.

Salary on scale rising to £1850 with placing according to qualifications and experience; superannuation (F.S.S.U.), children's allowance, and removal allowance. University houses available from time to time.

Further information may be obtained from THE SECRETARY, THE UNIVERSITY, ABERDEEN, with whom applications (20 copies) giving names of three referees, should be lodged not later than 3rd JUNE, 1960. Applicants outside the British Isles may submit one copy of application.

C 95

THE UNITED LIVERPOOL HOSPITALS

Applications are invited for the post of ENGINEERING ASSISTANT to assist the Superintendent Engineer. The duties will include the preparation of drawings and specifications. Applicants should be competent draughtsmen and experienced in heating and ventilating and general engineering work. The possession of an appropriate qualification would be an advantage. The salary for a person of 21 years and with three years' experience is £550 per annum and is on a scale which rises to £750 per annum. Terms and Conditions of Service are those of the appropriate Whitley Council.—Apply by the 30th May, 1960, stating age, qualifications, experience and the names and addresses of three persons to whom reference may be made, to the SECRETARY, THE UNITED LIVERPOOL HOSPITALS, 80, RODNEY STREET LIVERPOOL, 1.

C 71

STATION ENGINEERS

AIR MINISTRY require STATION ENGINEERS (G.D.) and STATION ENGINEERS (MECH.) at R.A.F. and Ministry of Aviation Stations. The work of Station Engineers (G.D.) consists of installation, operation and maintenance of high and medium voltage electrical distribution systems, electrical power and lighting installations, control systems and generating plant: knowledge of heating and ventilating plant and diesel engines an advantage. Station Engineers (Mech.) are concerned with diesel power plant, steam and hot water heating systems, refrigeration and air conditioning and miscellaneous workshop plant, tools and equipment. Candidates must hold O.N.C. Elec. or Mech. (City and Guilds Electrical Technicians Certificates/2nd class M.O.T. Certificate or equivalent and must also have had recognised apprenticeship with firm of good repute plus 3 years' employment in electrical or mechanical and engineering preferably on operation and maintenance of mine, factory or workshops plant and services. Preference to candidate with supervisory experience.

Salary ranges from £680 to £785 rising by annual increments to £850. Commencing salary dependent upon age, qualifications and experience. Opportunities for promotion up to Tech. Grade A, maximum salary £1565 (National rate). Pension prospects. 5-day week. 18 days paid leave a year initially. Internal training courses are provided and attendance at technical colleges by suitable candidates is sponsored. Overseas tours for which special allowances are payable in addition to higher salary. Applicants, who must be natural born British subjects up to age 55, should write stating age, qualifications and experience, to MANAGER (P.E.1), MINISTRY OF LABOUR, P. & E. REGISTER, ATLANTIC HOUSE, FARRINGDON STREET, E.C.4. No original testimonials should be sent. Only applicants selected for interview will be advised.

G 885

UNIVERSITY OF DURHAM

KING'S COLLEGE, NEWCASTLE UPON TYNE, 1

THE COUNCIL OF KING'S COLLEGE invite applications for a LECTURESHIP in MECHANICAL ENGINEERING.

Applicants should preferably hold an honours degree in Engineering and should have had some professional experience since graduation.

The commencing salary will be determined at a suitable point on the Lecturers' Scale which will rise by annual increments to a maximum of £1850 in accordance with the qualifications and experience of the successful applicant.

Family allowance and F.S.S.U. benefits will be payable.

Further particulars may be obtained from the REGISTRAR OF KING'S COLLEGE, to whom applications (12 copies) together with the names and addresses of three referees, should be addressed so as to reach him not later than the 11th JUNE, 1960.

C 114

CITY OF NOTTINGHAM

CITY ENGINEER'S DEPARTMENT

ASSISTANT ELECTRICAL ENGINEER

SALARY—£765-£1065

Applications are invited for the above position in the City Engineer's Department, Nottingham, in Grade APT II (£765-£880 p.a.) or APT III (£880-£1065 p.a.). Grade and starting salary will depend on qualifications and experience.

Applicants must have the ability to design electric-lighting and power installations for new buildings. The work in the office is on a five-day week basis.

Applications on forms to be obtained from R. M. FINCH, O.B.E., M.I.C.E., CITY ENGINEER AND SURVEYOR, GUILDHALL, NOTTINGHAM, must be returned to him not later than FRIDAY, 3rd JUNE, 1960.

C 111

WESTERN REGIONAL HOSPITAL BOARD

SCOTLAND

ENGINEERS

Applications are invited for the following posts—

(*a*) ENGINEERS—General Grade, salary scale £910-£1600 per annum. Applicants should either be Corporate Members of the Institutions of Mechanical or Electrical Engineers (who will enter the scale at £1160), or Corporate Members of the Institution of Heating and Ventilating Engineers (for whom there is a bar at £1400 per annum). Graduate Members of above Institutions may be considered suitable but the maximum salary in this case will be limited to £1205 per annum. Applicants should have practical and theoretical experience of design, installation, operation and maintenance, and should be capable of preparing specifications, estimates and drawings and advising generally on engineering services in buildings.

(*b*) ENGINEERING DRAUGHTSMEN—salary scales,

Grade I	...	...	£1030-£1250
Grade II	...	...	£870-£1010
Grade III	...	...	£550-£850

(*c*) CLERK OF WORKS (Engineering)—salary scale, £800-£1050.

(*d*) TRACER (FEMALE), £230-£565 per annum.

Applications, stating age, training, qualifications, experience and present appointment, should be sent, together with names and addresses of three referees, to the SECRETARY, WESTERN REGIONAL HOSPITAL BOARD, 351 SAUCHIEHALL STREET, GLASGOW, C.2.

C 110

APPOINTMENTS OPEN

CIVIL ENGINEER

A. BOAKE, ROBERTS & CO. LTD. require, for the design of new projects, a QUALIFIED CIVIL ENGINEER—preferably A.M.I.C.E., with experience in industrial building design and construction. Age probably between 30 and 40, salary £1200 to £1500 per annum according to age and qualifications. The appointment is permanent and pensionable.—Applications should be addressed to THE PERSONNEL MANAGER, 100 CARPENTERS ROAD, LONDON, E.15.

C 74

REPRESENTATIVE

REPRESENTATIVE wanted by BARLOW & CHIDLAW, LTD., MANCHESTER 6, to take over their Midland area, in which they are well represented, on a commission basis. A good knowledge of gearing would be required. The vacancy caused by sudden death.—Replies giving full details of past experience will be treated in confidence.

C 32

SENIOR DESIGNER

required by DRYSDALE & CO., LTD., YOKER, GLASGOW, W.4. An excellent opportunity is open to a suitable man over 25 years of age. Applicant should preferably have experience in the design and installation of Centrifugal Pumps and their associated machinery. Life Assurance and Pension Scheme in operation. Five-day week.—Apply to the SECRETARY, giving full details of qualifications and salary required.

C 58

DRAUGHTSMAN

A PROGRESSIVE ENGINEERING COMPANY in the Victoria Area of London requires a DRAUGHTSMAN for a responsible post in small Drawing Office. This post offers good prospects and an attractive salary to a man with general engineering experience. Five-day week and pension scheme in operation. Please send details of experience to THE CHIEF DRAUGHTSMAN, THE WELLMAN BIBBY COMPANY LTD., PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1.

C 105

VACANCIES FOR

CIVIL ENGINEERS

IN THE MINISTRY OF WORKS NORTHERN NIGERIA

Vacancies exist in this Ministry for Civil Engineers, and further vacancies will continue to arise for development work on road and bridge construction and for water supply schemes.

Duties

The duties of these posts will consist of preliminary reconnaissance, detailed survey work, investigations of site for bridge construction, road, bridge or water supply design works, bills of quantities in connection with these works and/or appointment as Resident Engineer to supervise construction projects. Also, engineers are appointed District Engineers in control of all works within a district.

Qualifications

The minimum qualification for appointment is a university degree giving an exemption from Sections I and II of the Institution of Civil Engineers examination, plus two years' post-graduate service *or* a pass in Section I and II of the Institution examinations, plus two years' post-graduate service *or* the equivalent qualifications in other countries. This minimum qualification qualifies an engineer to enter at the bottom of the salary scale. Incremental credit is granted for every year of service after obtaining this minimum qualification.

Contract of Service

In the first instance, engineers will be employed for a tour of duty between 12 and 24 months, plus leave, which is granted at the rate of 7 days for every month of residential service.

Passages

Free first class return passages for a Government officer and his wife are provided once per tour. In addition, financial assistance is given towards the cost of children's passages.

Salary Scale

The salary scale runs from a minimum of £1440 to a maximum of £2202 per annum. In addition, children's allowances are payable for up to three children at the rate of £120 per annum for the first child, £96 per annum for the second and £72 for the third child. Motor car and travelling allowances are also payable and a gratuity at the rate of £150 per annum is payable at the end of each tour of contract service.

Associate Membership of the Institution of Civil Engineers

Facilities are available locally for engineers who have not yet completed their Civil qualification to be examined in Northern Nigeria for Section III (the professional interview examination) of the Institution examinations. Experience gained in the Ministry of Works is acceptable to the Institution of Civil Engineers for this purpose.

Method of Application

Applications from engineers, who should not be more than 50 years of age, should be addressed to the

RECRUITMENT SECRETARY,
NORTHERN REGION OF NIGERIA RECRUITING AGENCY,
NIGERIA HOUSE, 9 NORTHUMBERLAND AVENUE, W.C.2

from whom further details may be obtained of other conditions of service, such as payment of outfit and touring equipment allowances, accommodation, medical facilities, income tax, cost of living, etc.

NORTHERN NIGERIA IS A GROWING COUNTRY:
WE WILL ALWAYS BE PLEASED TO HEAR FROM CIVIL ENGINEERS,
CIVIL ENGINEERS LIKE YOU ARE ALREADY THERE

C101

ADMINISTRATIVE COUNTY OF CARMARTHEN

THE THOMAS AND ELIZABETH WILLIAMS SCHOLARSHIPS (LLANELLY SCHOOL DISTRICT)

APPLICATIONS are invited for **POSTGRADUATE SCHOLARSHIPS** from university graduates and also persons possessing professional or technical qualifications equivalent to a university degree. Applications are not restricted to a particular field of study, but special consideration will be given to applicants desiring to enter upon post-graduate work in the United States of America. The Scholarships to be awarded will be of a substantial character and normally are intended to meet the cost of tuition, maintenance and travel of the successful applicants.

Applicants must have been resident for at least two years during the ten years immediately preceding the date of application within:

(*a*) The area comprising the Llanelly School District, viz., the Borough of Llanelly and the Parishes of Llanelly Rural and Pontyberem, as at present existing;

(*b*) The Administrative County of Carmarthen with the exception of the Borough of Kidwelly together with that part of the Parish of St. Ishmael served by the Llansaint County Primary School as at present existing, the urban district of Burry Port and parishes of Tembray, Llandefeilog, Llangengeirnel and the remainder of the parish of St. Ishmael.

In the award of Scholarships preference will be given to candidates who satisfy the requirements within category (*a*) above, and if there are no worthy applicants or not a sufficient number of worthy applicants to satisfy such requirements, Scholarships may be granted to persons who satisfy the requirements of category (*b*). Candidates must not be above the age of thirty years at the date of application for a Scholarship.

Further particulars and forms of application are obtainable from the undersigned on receipt of a stamped addressed foolscap envelope, and completed applications must be returned not later than 18th June, 1960.

IORWERTH HOWELLS,
DIRECTOR OF EDUCATION.

COUNTY EDUCATION OFFICES,
CARMARTHEN.

C 77

BRITISH TRANSPORT COMMISSION

invite applications for the following post at the BRITISH RAILWAYS SCHOOL of TRANSPORT, DERBY:—

DIESEL TRACTION INSTRUCTOR
(Mechanical Engineering)

SALARY RANGE, £838-£1130.

INSTRUCT TECHNICAL and SUPERVISORY STAFF in the principles, construction, operation and maintenance of Diesel Locomotives and Multi-Unit Stock. Sound theoretical knowledge and practical experience of Medium and High Speed Diesel Engines used in Rail Traction essential. Knowledge of electrical transmission and control systems desirable. Professional Mechanical Engineering qualifications required. Experience in teaching desirable. Post is non-residential.

Superannuation scheme: certain travel facilities: medical examination.—Write, stating age, qualifications and experience to DIRECTOR OF ESTABLISHMENT, BRITISH TRANSPORT COMMISSION, 222 MARYLEBONE ROAD, LONDON, N.W.1, within FOURTEEN DAYS.

C 116

I.C.I. (HYDE) LIMITED
MECHANICAL ENGINEER

I.C.I. (Hyde) Limited, manufacturers of polyvinyl coated fabrics, plastic sheet and film and related products, has a vacancy for a Mechanical Engineer. Age 25-35. Duties will include machine design, plant development work and plant layout. Applicants should have a good honours degree followed by practical training and some experience of design and development work. Experience in the design of machinery similar to that used in the rubber, plastics, or leathercloth industries desirable, but not essential.

Conditions of employment include an attractive salary, membership of the Staff Pension Fund and participation in the Company's Profit-Sharing Scheme. A married man will receive assistance with removal expenses and may also be paid a lodging allowance for a period of up to six months whilst maintaining two homes. In addition, he will be eligible for assistance with house purchase.

Write, giving brief details of age, qualifications and experience to

Staff Officer,
I.C.I. (HYDE) LIMITED, Newton Works, Hyde, Cheshire

C 85

ADMINISTRATIVE COUNTY OF CARMARTHEN

THE THOMAS AND ELIZABETH WILLIAMS SCHOLARSHIPS (KIDWELLY SCHOOL DISTRICT)

APPLICATIONS are invited for Postgraduate Scholarships from university graduates and also persons possessing professional or technical qualifications equivalent to a university degree. Applications are not restricted to a particular field of study, but special consideration will be given to applicants desiring to enter upon postgraduate work in the United States of America. The Scholarships to be awarded will be of a substantial character and normally are intended to meet the cost of tuition, maintenance and travel of the successful applicants.

Applicants must have been resident for at least two years during the ten years immediately preceding the date of application within:

(*a*) The Borough of Kidwelly together with that part of the Parish of St. Ishmael served by the Llansaint County Primary School as at present existing;

(*b*) The Urban District of Burry Port and the Parishes of Pembrey, Llandefeilog, Llangendeirne, and the remainder of the Parish of St. Ishmael.

(*c*) The Administrative County of Carmarthen with the exception of the Llanelly School District, viz., the Borough of Llanelly and the Parishes of Llanelly Rural and Pontyberem as at present existing.

In the award of Scholarships preference will be given to candidates who satisfy the requirements within category (*a*) above, and if there are no worthy applicants or not a sufficient number of worthy applicants to satisfy such requirements, Scholarships may be granted to persons who satisfy the requirements of category (*b*) and thereafter category (*c*). Candidates must not be above the age of thirty years at the date of application for a Scholarship.

Further particulars and forms of application are obtainable from the undersigned on receipt of a stamped addressed foolscap envelope, and completed applications must be returned not later than 18th June, 1960.

IORWERTH HOWELLS,
DIRECTOR OF EDUCATION.

COUNTY EDUCATION OFFICES,
CARMARTHEN.

C 78

THE GLACIER METAL COMPANY

Invites applications for the post of

SENIOR APPLICATIONS ENGINEER

The Company has recently established within its Research and Development Organisation a new department whose function is to use the latest research knowledge in advising customers on all aspects of bearing design.

An appointment has now to be made in which the Engineer will be responsible to the Manager of the new department and will have initially one assistant. The work entails a wide and interesting range of contacts in the engineering industry.

As Technology advances new mechanical designs raise new bearing problems and new bearing designs make possible innovations in the design of machinery. A senior Applications Engineer is responsible both for devising solutions to bearing problems raised with the Company by its customers and for searching out areas where such innovations are practical.

Applicants should have a good Honours Degree in Engineering, Physics or Mathematics, together with a completed apprenticeship. Experience in Research, Design or Development work would be useful.

Salary Range: £1350 to £1830 per annum.

Applications should be sent to
PERSONNEL DIVISIONAL MANAGER
(REF. SAE),
THE GLACIER METAL COMPANY
EALING ROAD, ALPERTON,
WEMBLEY, MIDDX. C 50

FURNACE ENGINEERS/DRAUGHTSMEN

FOUR SENIOR DESIGN/SECTION LEADERS and EIGHT DRAUGHTSMEN required for all types of furnaces and associated mechanical equipment as used in steelworks and non-ferrous industries.

Experience in steelworks and non-ferrous industries desirable but not essential.

Salary will be dependent on qualifications and experience.

Non-contributory pension scheme.

Disturbance allowance considered.

Applications to the

DIRECTOR OF ADMINISTRATION,
SALEM ENGINEERING CO., LTD.,
MILFORD HOUSE,
MILFORD, NR. DERBY.

C 66

MECHANICAL DESIGN ENGINEERS

are required for work on light electro-mechanical equipment.

Successful Candidates, who should be of Degree or H.N.C. standard, would join Research Groups of Electrical Engineers developing prototype equipment. Housing accommodation is available if required. Apply stating age, training and experience to:—

The Secretary.
BARR & STROUD LIMITED,
Anniesland. Glasgow. W.3,
quoting 201/T.17 on the envelope.

C 76

THE MANCHESTER SHIP CANAL COMPANY

ASSISTANT CIVIL ENGINEERS

THE MANCHESTER SHIP CANAL COMPANY invite applications for the appointment of ASSISTANT CIVIL ENGINEERS on the established staff of the Chief Engineer. Scale of salaries, £845 at age 25, rising by annual increments to £1310 at 38 with prospects of promotion to higher grades at salaries up to £1795.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications, and should have experience in design, specifications, construction and maintenance of Civil Engineering works. Harbour and dock experience is preferable but not essential.

Successful applicants will require to become members of the Company's Contributory Superannuation Scheme.

Applications, stating age, qualifications and experience should be addressed to the CHIEF ENGINEER, THE MANCHESTER SHIP CANAL COMPANY, SHIP CANAL HOUSE, KING STREET, MANCHESTER, 2, not later than 18th JUNE, 1960. C 104

ENGINEER

Progressive engineering firm requires CAPABLE ENGINEER for DESIGN COMPLEX MODERN WELDED PLATE and TUBULAR STRUCTURES. Some mechanical experience an advantage. Salary according to qualifications and experience. Permanent pensionable appointment.—BOX C 87, Offices of ENGINEERING.

ENGINEER

ENGINEER for INSPECTION of CRANES AND LIFTING PLANT required by leading Insurance Company. Must have drawing office experience of design of Cranes, also National Certificate in Mechanical Engineering. Areas South Essex and Liverpool. Starting salary, £800—other benefits—not over 38 years.—permanent.—Write BOX EN 417, L.P.E., ROMANO HOUSE, 399/401, STRAND, LONDON, W.C.2. C 82

RESIDENT SITE SUPERVISORS

J. DOUGLASS MATHEWS & PARTNERS, Chartered Architects, require experienced resident site supervisors on a permanent staff basis. Applicants must be prepared to go anywhere in the United Kingdom for resident appointment of one, two or three years. Salary £1250-£1750, according to job, experience and qualifications. Applicants to give names of at least three architect or engineer references.—Reply to 3, EBURY STREET, LONDON, S.W.1. C 47

MAINTENANCE ENGINEER

A light engineering company in the Midlands would like to hear from a Mechanical Engineer capable of successfully implementing a planned maintenance scheme from scratch, embracing buildings, electrical and mechanical maintenance of plant and buildings. There are 100 tradesmen and 200 others engaged on maintenance. Applicants must be able to substantiate their ability to achieve success in this project by giving reliable evidence from their past achievements.

Apply in confidence to BOX C 112, Offices of ENGINEERING.

DESIGNERS FOR SOUTH AFRICA

Large leading firm of heavy engineers and founders, undertaking the manufacture of heavy machinery and plant for mining, petroleum, chemical and allied industries, requires DESIGNERS with minimum qualification Higher National Certificate and several years' experience in design work. Candidates with lesser qualifications but with more extensive experience in one of the above mentioned fields will also be considered. Interesting varied work in mechanical design calculations and on drawing board requires sound ability in both.

Salary in accordance with ability, experience and qualifications. Liberal leave with additional long service benefits after six years. Medical benefit and Pension funds. Housing and assisted passage facilities available.

Apply in writing, giving full details of age, experience, qualifications and marital status and enclosing a recent photograph, to

THE LONDON REPRESENTATIVE,
VANDERBIJL ENGINEERING CORPORATION LTD.,
723/737, THE ADELPHI,
JOHN ADAM STREET,
LONDON, W.C.2. C 117

EXPERIENCED SALES ENGINEER

EXPERIENCED SALES ENGINEER required, for East Anglia, by pump manufacturers, to cover industrial marine and agricultural fields; car and expenses provided; contributory pension scheme; own staff advised of vacancy.—Applications with full details stating salary required, to PUMP DEPARTMENT MANAGER, GILBERT GILKES & GORDON LTD., KENDAL, WESTMORLAND. C 109

ICI

METALS DIVISION

DESIGN ENGINEER

A vacancy exists in the ENGINEERING DEPARTMENT (of I.C.I. Metals Division) at WITTON, BIRMINGHAM, for an ENGINEER to take charge of design, installation and commissioning of vacuum plant for the manufacture of new metals.

The successful applicant will be expected to work on his own initiative under the general guidance of a senior engineer and should be capable of preparing and maintaining programmes for complete projects. Essential qualities are an original and scientific approach to design coupled with the ability to work well with other design and service sections.

Applicants should preferably be 30 to 35 years of age and should possess qualifications of degree standard or equivalent in Mechanical and/or Electrical Engineering or Physics, together with considerable experience in the design and installation or operation of high vacuum furnaces or process plant.

Commencing salary will be dependent on age, experience and qualifications and there is opportunity for a man of good calibre and potential to make rapid advancement. Conditions of employment include membership of the Staff Pensions Fund and Employees Profit Sharing Scheme. Assistance will be given towards house purchase and removal expenses for a married man.

Please write for an application form to the Assistant Personnel Manager (Staff),

IMPERIAL CHEMICAL INDUSTRIES LIMITED,
Metals Division,
P.O. Box 216,
Kynoch Works,
Witton, Birmingham 6,

quoting **Eng/427/ENG**

C 113

FORD

ESTIMATING STAFF

for future model programmes

Ford Motor Company Limited is planning in addition to the £70 million expansion programme announced recently, comprehensive future model programmes. These plans offer exceptional opportunities for experienced estimating engineers.

Immediate vacancies are available in the team working on the preparation of cost targets and estimates for future cars, vans, trucks and tractors. There is considerable variety and scope in these appointments as the complete range of components is covered and appointments will be made both in central purchasing and in the main manufacturing groups of the Company. Applicants must have a sound engineering background coupled with practical experience in mass production techniques, estimating and time study. National Certificate in mechanical engineering or equivalent standard is essential.
Salary will be paid according to age, qualifications and experience. Promotion will be on merit alone.

Replies should be addressed to

MR. H. G. PEARMAN
TRAINING AND RECRUITMENT DEPARTMENT
FORD MOTOR COMPANY LIMITED
DAGENHAM · ESSEX

quoting on the envelope 'Reference PCE'

C 100

DEVELOPMENT ENGINEER

A Graduate Engineer is required for the appraisal of new techniques and study of materials, equipment and design leading to the preparation of Standards, etc., for equipment in the low temperature field.

Write :—

Personnel Manager,
AIR PRODUCTS (G.B.) LTD.,
49/50 Poland Street,
London, W.1.

C 72

HARVEY

require

SENIOR DRAUGHTSMEN AND ESTIMATORS

with experience in pressure vessel and large welded fabrication work for the Oil and Chemical Industries to British and American Codes.

Assistance will be offered, if necessary, with regard to accommodation.

Apply, stating age, full details of experience and qualifications, and salary required, to:

Personnel Manager,
G. A. HARVEY & CO. (LONDON) LTD.,
WOOLWICH ROAD,
LONDON, S.E.7.

C 115

PLANNER/ SCHEDULER

to prepare Project Schedules and Programmes for orders and work load forecasts for the Workshops and Engineering Department.

Applicants must have experience as Planners for a Process Equipment Fabricator and be in possession of H.N.C. (Mech.) or equivalent in experience.

Write:

Personnel Manager,
AIR PRODUCTS (G.B.) LTD.,
49/50 POLAND STREET,
LONDON W.1.

C 73

APPOINTMENTS WANTED

EXECUTIVE DIRECTOR

Energetic 30 years' old executive Director, with sales and production experience in light engineering industry seeks Directorship with progressive small or medium size company engaged in the production and sales of their own branded products. Capital available.—Write BOX MY/66, c/o 95, BISHOPSGATE, E.C.2.

C 80

RESEARCH ASSISTANTS

THE CEMENT AND CONCRETE ASSOCIATION

has vacancies for RESEARCH ASSISTANTS in the Structures and Roads Departments of its Research Station. Requirements are an honours degree in engineering and two or three years' experience in research, design office or in construction. The posts are permanent and pensionable. The work qualifies for associate membership of the Engineering Institutions and, in appropriate instances, gives opportunities for obtaining higher degrees.

Applications to

DIRECTOR OF RESEARCH,
CEMENT AND CONCRETE ASSOCIATION,
WEXHAM SPRINGS,
FRAMEWOOD ROAD,
STOKE POGES,
SLOUGH, BUCKS.

C 107

'Engineering' Appointments Section

ADVERTISEMENT RATES

CLASSIFICATIONS: Public Appointments, Appointments Open, Appointments Wanted.

TYPES OF ADVERTISEMENTS:

(a) "Appointments Illustrated" and illustrated careers advertisements: photographs or drawings may be used in conjunction with type matter.

Rates:	per page (12 in. by 9 in.)	£100
	half page	£54
	quarter page	£29

(b) Semi-display: type matter, with or without surrounding rule, name block or symbol.

Rates:	per page (12 in. by 9 in.)	£100
	per half page	£54
	quarter page	£29
	per single column inch	£2 14s.

(c) Single column "run-on" advertisements: approximately 6 words to the line, 12 lines to the inch.

Rate per line .. .. 4s. 6d.
(Minimum charge 18s.)

SERIES DISCOUNTS: 5 per cent. on 6 insertions; 10 per cent. on 13; 15 per cent. on 26.

BOX NUMBER: 2s.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

Company Meetings

Quarter page, £29; half page, £54; full page, £100.

COPY DATE: First post Monday.

BLOCKS: To be mounted ready for printing. Screen 100.

ORDERS TO: "Engineering" 36, Bedford Street, London, W.C.2. (Telephone TEMple Bar 3663).

COMPANY MEETING

NEWTON, CHAMBERS & COMPANY LIMITED

IMPROVED TRADING POSITION

The seventy-eighth annual general meeting of Newton, Chambers & Company Limited was held on May 12 at Sheffield, SIR PETER ROBERTS, Bt., M.A., M.P. (the Chairman) presiding.

The following is an extract from his circulated statement:—

The gross trading profit of the Group, before charging depreciation, was £1,466,671, compared with £1,293,926 in 1958, an increase of £172,745. The consolidated profit totalled £1,067,597 and, after providing for taxation, there was £558,097 available for appropriation.

The Directors are of the opinion that the improved trading position justifies an increase in the dividend from 16 per cent to 17½ per cent, and accordingly recommend a final dividend of 11½ per cent. In addition they propose to transfer £200,000 to General Reserve which will then stand at £1,550,000.

After these appropriations the carry forward will be increased by £74,479 to £477,249.

You will recall that last year I stated that a revaluation of the Group's fixed assets had been carried out as at January 1, 1959. This has now been incorporated in the Accounts for 1959 and the effect has been to increase the net book value of the assets by £2,195,127 which amount has been combined with the balance on the Replacement of Fixed Assets Reserve to form a General Capital Reserve totalling £3,386,099. This revaluation has been made on a conservative basis.

Similarly, the market value of the quoted investments bore no resemblance to the book value which had remained unchanged since 1954. Therefore these investments have been revalued at the market prices ruling on December 31, 1959, and at the same time the present value of the unquoted investments has now been reassessed. This produced a surplus of £1,561,689 which has been credited to the Investment Reserve.

Expenditure on new buildings and plant was lower than in 1958 and totalled £486,000, of which £258,000 was spent at Thorncliffe and £228,000 at Waterside Works, Ipswich. At the end of 1959 we were committed to further capital expenditure of £866,595 and, in fact, it is expected that over £1 million will be spent in 1960.

The Chemicals Division had another year of excellent progress and the previous year's record turnover and profit were substantially exceeded in both home and export markets. Sales of all Izal products continued to increase, particularly the Izal Medicated Roll and Zal Disinfectant.

The Engineering Division achieved a record turnover and profit despite the continuing reduced demand for capital plant by the basic industries. The results achieved were largely due to the diversification of the Division's activities, made possible by the re-equipment and extension programme which has been carried out in recent years. Despite the tendency of the market for the traditional type of fireplace to decline, the demand for Redfyre appliances continued at a high level.

The Excavator Division's turnover showed a marked increase over 1958 and was only just short of the record achieved in 1957. The improvement was particularly evident in the export market due to the more liberal import policy adopted by Commonwealth and certain foreign countries.

Ransomes & Rapier Limited

The sales turnover was slightly higher than the previous year's record but the 1958 rate of profit was not maintained. Production showed no decline in profitability but the rationalisation of products following the merger made it necessary to write down slow moving stocks, particularly of Excavators and Cranes, and also certain development expenditure had to be written off.

Integration of production arrangements with those of the Parent Company has made considerable progress. The Waterside Works Foundry has been closed and the work transferred to Thorncliffe so that the foundry production facilities of the Parent Company are more fully occupied.

It is always difficult to foresee the future in the rapidly changing economic climate of today. Consumer expenditure continues to rise and this should help the sale of Izal and Redfyre products.

All the signs are that national capital investment in 1960 will be considerably higher than in 1959 and this should be reflected in the order books of the Engineering and Excavator Divisions and of Ransomes & Rapier. Your Directors, therefore, intend that the Group shall continue to expand, as they are confident that the long-term demand for its products will steadily increase.

The report and accounts were adopted.

C 11

Companies

Queens and Eagles

NATIONAL discrimination in favour of a country's own shipping is an old and perhaps increasing device. The CUNARD COMPANY's annual report shows in detail a bad case, that of India. Indian Government discrimination, freely practised despite the dependence of India upon enormous foreign aid contributions, caused the BROCKLEBANK interests of Cunard a "very unhappy year." It also caused Cunard to suspend its services between India and the North Atlantic ports of the USA although the service to United States Gulf ports was retained and is showing some improvement.

The Cunard gross operating surplus fell from £5,670,919 in 1958 to £5,039,666 last year, a drop almost entirely due to the decline in Brocklebank earnings. PORT LINE profits were slightly down while CUNARD STEAM-SHIP results were up by rather more than the Port Line fall.

The chairman, Sir John Brocklebank, revealed that, while their design team had produced a few minor improvements which would reduce cost and improve profit, the Board was still convinced that the replacements for the Queens should be two ships, of about 75,000 tons each and with a service speed of 30 knots.

Perhaps of even greater importance to the future for Cunard than their Weekly Express Service across the Atlantic is their link with civil air transport. The buying of EAGLE AIRWAYS is going on. At the moment their fleet is made up of Vikings, Viscounts, Douglas DC6C's and a commercially used Britannia which is being evaluated. A good example of going where the traffic is comes from Eagle's recent success in gaining Government approval to operate on the London-Bermuda-Nassau route.

The great accumulated passenger carrying experience of Cunard, and their established offices, 17 in the US, 9 in Canada and 23 in Europe, should be a potent factor in greatly increasing the scope and profitability of Eagle's activities—and of its need for aircraft.

Newton, Chambers £1 Million Expansion

The capital investment schemes of the Sheffield engineering and chemical company, NEWTON, CHAMBERS & COMPANY Limited, for this year, include a complete new chemicals factory and additional plant re-equipment in the engineering and excavator divisions.

The company's Waterside works will have a new welding shop, new stress relieving facilities, a paint and shot blasting department, completion of the new office block, and some retooling.

While in 1959 the spending on new building and plant was down to £486,000 from the higher figure of the year before, the cost of this year's investment is expected to exceed £1 million

The gross trading profit of the group for last year was up by £172,745 to a total of £1,466,671. A planned stock reduction policy during the year led to the value of stocks and work in progress being cut by £772,827. This in turn enabled £500,000, borrowed on short term, to be repaid.

Despite the continued reduced demand for capital plant the engineering division reached a record turnover, largely due to the re-equipment and extension plans of recent years.

Sir Peter Roberts, the Newton, Chambers chairman, observing that all the signs are that 1960 will see higher levels of capital investment than last year, believes that this will be reflected in the order books of the engineering and excavator sections.

The benefits are beginning to be felt of licence agreements made with foreign firms for the manufacture of gas making and chemicals plant and steel production. Orders have been secured, under the Bischoff agreement, for sulphur extraction plant for the gas industry. This is additional to work on high pressure gas purification.

From Candles to Power Tools

Every 20 seconds in the working day a completed electric drill moves silently up the inclined production conveyor at the Battersea factory of S. N. BRIDGES, the power tool makers.

The full and complete development of the company on their 17 acre site beside the Thames will give them buildings of more than 600,000 sq. ft, the largest factory in central London and the biggest works in Europe devoted to power tools.

The most eloquent comment on the growth of the Bridges concern from its founding by Mr. G. N. Bridges, now managing director, in a small London garage 19 years ago, is found in the despatch department.

Alongside crates stencilled Lagos and Surinam, are others waiting shipment to Japan and Salisbury, Rhodesia.

The key year in the company's growth was 1948, when production of electric tools began and when JOHN BROWN & Company acquired an interest in the firm. Rapid expansion, based on a reputation for precision engineering, accentuated the space problem. In 1957 the "Neonic Eye" development was introduced. This device shows whether or not the drill is correctly earthed. An important safety step and one which produced an increased demand that made the difficulties of the company's site in Fulham even more acute.

The answer was found at York Road, Battersea. Production at the new works there began only 20 minutes after opening in August of last year. Some well coordinated efforts in removal and preparation having been put in during the annual two-week close down.

The York Road site has its significance. It was formerly occupied by Price's Candle Works, a concern that in its day supplied a product as contemporary as the power tool in ours.

Before the candle company came, the site had included Sherwood House, once owned by the fashionable Mrs. Fitzherbert, and York House, built by a Bishop of Durham who later became Archbishop of York. The beautiful Battersea enamels, enamelled miniatures on copper, were made on the present site.

The candle company sent its products abroad almost as freely as the far reaching Bridges concern.

A major benefit to the company of the move to Battersea has been the added capacity which it has been possible to provide for industrial tools. A substantial service department has now got into its stride.

One of the company's area managers told ENGINEERING that 48 hours might be regarded as a reasonably accurate estimate of the interval between a tool arriving for servicing and leaving again in working order. Great attention is given to the use of the cartridge motor, whose withdrawal and replacement is a matter of minutes.

By the time its introduction as an occasional suction fan has been developed for cooking time in the kitchen, and perhaps as a power mop for washing up, the ubiquitious electric tool will perhaps reach not one per household but one per person numbers.

Dickens Commemorated at New Office Block

Marley's ghost, Barnaby Rudge, Mrs. Gamp and Mr. Micawber all appear at

Ferguson House, the new LAING DEVELOPMENT Company five storey office block in the Marylebone Road. Devonshire Terrace, which once stood on the site, numbered Charles Dickens among its former residents. While living there he wrote six of his novels.

Along with Little Nell and David Copperfield, some of the outstanding characters from the novels are shown in an intaglio relief sculpture placed at a specially designed area in one corner of the building. The sculpture is the work of Estcourt J. Clack (inset) and shows the great novelist in the later years of his life.

Ferguson House, which was built by JOHN LAING AND SON Limited, has its gas fired boilers, for the low-pressure radiator system, in the roof. It has been leased to BRITISH PLASTERBOARD (HOLDINGS) Limited.

Steel Companies Combine in New Investment Group

Nine leading British steel companies have cooperated to form the BRITISH ORE INVESTMENT CORPORATION Limited jointly with the BRITISH STEEL CORPORATION Limited.

The object of the new company, BOIC, is to hold investments in foreign ore-mining companies, a job previously done by British Steel, which is a company associated with the British Iron and Steel Federation.

The main shareholders in BOIC are the British Steel Corporation (with 1,000,000 £1 shares), the Steel Company of Wales (700,000), Colvilles (650,000), South Durham Steel and Iron (625,000), Dorman Long (Steel) Company (550,000), John Summers (400,000), Richard Thomas and Baldwins (400,000), Consett Iron (250,000), Guest Keen Iron and Steel (250,000), United Steel Companies (175,000).

BOIC has taken over a number of investments including the 20 per cent interest in Société des Mines de Fer de Mauritanie (MIFERMA), a £60 million scheme in French West Africa. This is a joint capital raising effort with French, German and Italian concerns. It is intended that MIFERMA shall eventually produce six million tons of iron ore a year.

The new company also assumes the 30½ per cent British participation in an ore mining company in Guinea, the Compagnie Minière de Conakry.

KLM Reaching Record Performances

The great cost of introducing new high speed air liners to major airline services is well known. But KLM, the profit-making Dutch airline, managed to introduce the Electra and the Douglas DC-8 to its routes in the last financial year and still come up with a record £1,447,000 (15·4 million guilders) profit.

British companies celebrate when turnover reaches ten million pounds, American when it ends the year in multiples of a hundred million dollars. For the Dutch it is guilders and KLM is able to report that its yearly traffic revenue has for the first time exceeded 500 million guilders (£46,992,000). The actual traffic income was 508·7 million guilders.

Another KLM record was the million mark passed in the number of passengers carried in 1959—1,104,000. The 22 aircraft the Dutch airline has on order will all join the present fleet of 92 planes this year or next.

KLM is the third largest of the world's airlines, and the aggregate distance flown by them last year would average five times round the globe every day.

Fiftieth Anniversary for Ball Bearing Firm

The SKEFKO BALL BEARING Company celebrates its jubilee year with a record turnover and the highest earnings of its history.

Founded in a small way in February, 1910, Skefko has progressed steadily to a position where 1959 ended with a profit of £829,749, against £610,373 in the previous year. As did many other companies, Skefko started 1959 with lower levels of activity due to the recession. Their recovery in the later months of the year was very rapid and recently the number of new orders has been so substantial as to affect the length of delivery dates.

The chairman, Sir Victor A. L. Mallet, recalling that the heavy spending on development and modernisation had produced capacity which was all now profitably in use. This sort of spending was likely to continue but it was hoped it could all be found from the company's own resources.

Skefko, with its parent company in Sweden—SKF—is part of a consortium which is to operate jointly the Echuca bearing factory, Victoria, Australia. The third leg in the consortium is RANSOME AND MARLES BEARING.

Aluminium Strip Mill with a Difference

A new strip mill which will be devoted to the rolling of aluminium alloys is the first of its type to be used for this purpose in Europe. The Sendzimir mill will roll the alloys in coil form at 1,600 ft per min.

AT THEIR Woodgate Works at Quinton, Birmetals Limited have commissioned a new strip mill for rolling aluminium alloys. It is expected to roll between 12,000 and 20,000 tons of sheet a year. The machine itself is a 50 in reversing mill capable of rolling metal in coil form at speeds up to 1,600 ft per min. The finished width of the coil obtained is 48 in and the thicknesses which can be produced range from 0·1875 in ($\frac{3}{16}$ in) down to 0·006 in minimum.

The mill is a Sendzimir cluster mill built under licence by W. H. A. Robertson and Company Limited of Bedford. This type of mill has been fairly widely used for steel, but this is the first time it has been used for aluminium alloys. Two 900 h.p. d.c. motors in tandem drive it, and each winder is driven by three 350 h.p, motors in tandem to provide a maximum tension of 25,000 lb. Use of an electrically operated disengaging coupling allows the inboard motor to be used on its own to provide the lower tension values up to 8,000 lb when light gauge material is being rolled. Provision has been made for automatic control of tension by the inclusion of load cells, one being fitted to each of the two deflector rolls, over which the tensioned strip passes.

The mill drives are supplied by four generators driven by an 11 kV 3,500 h.p. motor and all the generators and mill drive motors and their control panels, supplied by Associated Electrical Industries Limited, are housed in a pressurised motor room. Cooling air is drawn through a Visco filter unit and discharged into a wind tunnel beneath the motor room by four 25 h.p. axial flow fans. This air is fed to all motors and generators, and the discharge of the resultant air pressure built up in the motor room is controlled by electrically operated roof ventilators which are under the control of the motor room attendant.

As with other Sendzimir mills, it is possible to change the work rolls in under a minute, so that the final pass can be made with highly finished rolls which give a mirror finish to the strip. This is because the work rolls are not driven, drive being to the four immediate back-ups; so that it is only necessary to take off the roll load and pull the work rolls out by hand when they are changed. The rolls are ground and polished on a Naxos roll grinder. A hydraulically operated form of crown adjustment is fitted which provides a range of camber control to the back-up roll assemblies and consequent control of strip shape. It is possible to adjust the camber to obtain absolutely uniform transverse gauge in the strip throughout the range of reductions and material tempers. Thickness gauges supplied by the Baldwin Instrument Company Limited, using strontium 90 as a source, are used to indicate the strip gauge and variation to the operator.

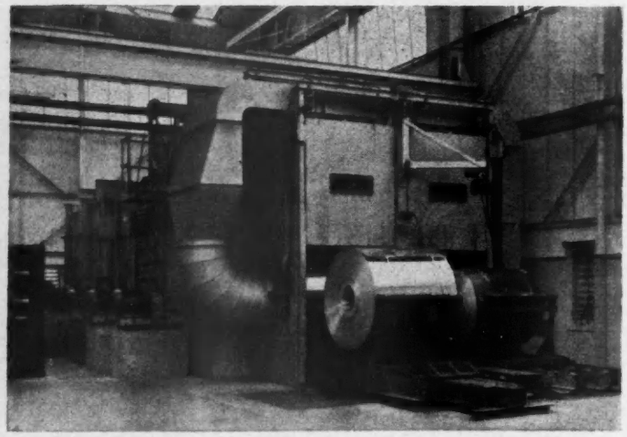
Hydraulic and lubrication supplies to the entry section, comprising a pay-off unit and feeder unit, and to the mill and winders, are obtained from pump units and their associated tanks in an oil cellar which also contains the clean and dirty rolling oil tanks with a combined capacity of 16,000 gallons. Rolling oil is supplied to the mill at 677 gallons per min and 150 lb per sq. in and is thermostatically controlled to maintain its temperature. Cooling is achieved with two Heenan and Froude water coolers in conjunction with two Serck heat exchangers.

A by-pass filtration system developed by Birmetals maintains a clean supply of rolling oil, which, in this type of mill, also serves as a lubricant to the mill back-up bearings.

COIL ANNEALING

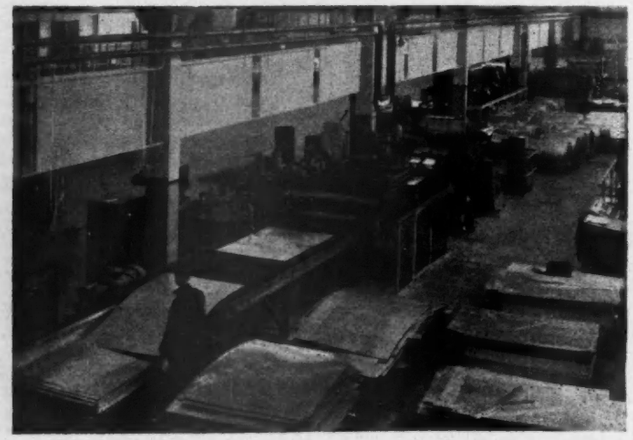
Intermediate annealing is carried out where necessary in the coil annealing furnace manufactured by Stordy Engineering Limited of Wolverhampton. The furnace which is rated at 550 kW with a capacity of 8,000 lb an hour,

Aluminium alloy strip, here being rolled from left to right on the Sendzimir mill, can be reduced from 0·1875 in to 0·006 in.



The coil annealing furnace will hold twelve 8,000 lb coils when working in a continuous cycle. It is used for intermediate annealing.

The welding line. Situated to the left of the control console is the flash butt welder which will take coils up to 52 in wide.



The cut-to-length line has a maximum strip speed of 350 ft per min, and will cut any length required from 24 in up to 192 in.

will hold 12 coils of 8,000 lb each when working on a continuous cycle. After being discharged from the high temperature zones at 450° C, the annealed coils pass through successive preheating zones, each one of which is a separate chamber closed off by doors and occupied also by an ingoing coil. The heat transfer which takes place effectively reduces the electrical loading for orthodox batch annealing to a little over half the normal figure.

SHEET ANNEALING

The flash annealing furnace will take sheets up to 8 ft wide, or two sheets 4 ft wide side by side, and has four heating zones totalling 600 kW. Continuous nickel alloy tapes carry the sheets through the furnace, which is 40 ft long, and its extension, in the form of a cooling chamber, which is 42 ft long. Extensive tests were carried out during the commissioning stages to ensure the maximum uniformity of material heating across the width. The conveyor speed may be varied from zero up to a maximum of 100 ft per min. The equipment was designed, manufactured and installed by GWB Furnaces Limited of Dudley. Material leaving this furnace is inspected on both sides before being passed on to the despatch bay and thence to the customer.

WELDING

A welding line takes coils up to 2,000 lb in weight and up to 52 in wide from the existing 4-high mill and flash butt welds them together providing, when edge trimmed, coils weighing up to 8,500 lb. These coils are approximately 50 in in diameter.

The line comprises a pay-off stand, feeder leveller, shears, welding unit, weld dresser, edge trimmer, and scrap chopper and coiling unit. Of the units, the pay-off stand was supplied by the Bronx Engineering Company Limited of Stourbridge, and the feeder leveller and shears are both items of existing plant which have been adapted for use in the line. The welding unit was designed by AI Electric Welding Machines of Inverness, and the weld dresser for removing the up-stand from the butt weld was supplied by Wadkin Limited of Leicester. The edge trimming and scrap chopping units were supplied by Auxiliary Rolling Machinery Limited of Tipton, Staffordshire, and the pinch rolls and tension reel are by the Wellman Smith Owen Engineering Corporation of London.

SLITTING

Finished coils from the mill bay are passed to a storage area ready for loading into the cut-to-length line. Provision has been made for a slitting line, to be fed from the same area, which will supply 52 in diameter coils slit to any width down to 1 in. This will have a maximum speed of 800 ft per min and a thickness range of from 0·080 in to 0·005 in. Strip to be supplied in coil form will have a length of over 7,000 ft by 0·020 in thick. This unit is being designed and supplied by Auxiliary Rolling Machinery.

The cut-to-length line has a maximum strip speed of 350 ft per min and a thickness range of from 0·080 in to 0·010 in, and will cut to any length from 24 in to 192 in. It is a Hallden unit manufactured and supplied by W. H. A. Robertson with motors and a motor-generator set supplied by the English Electric Company Limited.

Explosive Forming of Metal Plates

In order to obtain information about the high speed forming of metal plates using high explosives, Vickers-Armstrongs (Engineers) Limited recently prepared some equipment at their Crayford Works and some explosive charges at their Thames Works so that they could carry out experiments into the technique.

To minimise expense, and at the same time to make the investigation as realistic as possible, it was decided to produce a one-twelfth scale model of the dome end of a pressure vessel. The blanks used were of 20 s.w.g. (0·036 in) bright mild steel plate, and the explosive charges were Tetryl (CE).

The equipment finally used to produce satisfactory results comprised a mild steel die and pressure plate, a vacuum pump, and a thin sheet metal cylinder about 16 in high. In use, the cylinder is attached to the upper surface of the blank by waterproof adhesive tape, and a thin film of grease is applied to the upper surface of the die, to provide an airtight joint before the blank is placed on it. Next, the pressure plate is fitted, and the explosive charge suspended in the cylinder, which is then filled with water. Finally, air is evacuated from under the blank before the charge is detonated.

Charges varying in weight from 30 grains to 80 drams were used in the experiments, and they were located between 2·5 and 8 in above the centre of the blank. In addition, the charges were made either cylindrical or hemispherical in shape. It appeared that the latter gave the most satisfactory results, although the evidence was by no means conclusive. It was found that, as with conventional press working, the pressure plate is essential to prevent wrinkling of the plate.

Indifferent results were achieved with a vacuum of 24 in of mercury, the residual air in the die causing dents in the dome ends. It was finally established that very satisfactory results could be obtained by using hemispherical charges of 400 grains located 2·5 in above the centre of the blank, a vacuum of 29 in of mercury, and 0·5 in entry radius on the die. The dome ends so produced varied extremely little dimensionally, there being virtually no spring-back of the material, and the finish was very good. Further, there was relatively little change in the thickness of the finished material, the maximum reduction being about 0·003 in. This, Vickers presume, can be attributed to the explosive force being applied almost instantaneously over the whole surface of the blank, whereas in conventional press work there is a concentration of stress at the nose of the punch.

They conclude that explosive forming cannot compete with press working in large quantity production of components of normal materials, though they consider that it can be economically attractive if small quantities are required, more particularly if the components are to be of good finish and dimensionally closely toleranced. Only a female die is required, and it is reported that good results have been obtained with wood, plastic and concrete dies, depending on the number of components required and the finish and dimensional requirements.

Finally, they say that, although explosive forming is a relatively new technique, it would appear that it is sufficiently practicable to warrant the consideration of designers and production engineers. Thus they agree with other firms who have used the technique.

Radiant Electric Heating for Stress Relieving

The General Electric Company Limited report the successful application of radiant electric heating for stress relieving a large welded steel structure, a bottom half turbine exhaust casing on a 200 MW turbo-generator, at their Erith engineering works. GEC are making two of these 200 MW machines for extensions to the Kincardine Generating Station of the South of Scotland Electricity Board.

It was decided to fabricate the two bottom half turbine exhaust casings for each of these machines as complete units and carry out stress relieving by electric heating. This was a departure from normal GEC practice on large reheat turbo-generators. The exhaust casings have previously been made in sections which were stress relieved in conventional furnaces before being bolted together to form a complete component. Each of the Kincardine casings is 47 tons in weight with overall dimensions of 21 ft 3 in by 17 ft by 8 ft 3 in high.

Due to the amount of metal and the complicated nature of the structure, calculation showed that it was necessary to use 68 single phase radiant heating elements each of 7½ kW rating. The positions of the heaters within the casing were carefully arranged to ensure even heating throughout the structure, and each heater could be individually controlled very simply.

The casing was placed on a firebrick base and most of the heating elements were suspended vertically inside although a number were floor-mounted at predetermined strategic points. After covering the open top with a ¼ in steel plate, the whole structure was encased in thermal insulation to a depth of 6 in. Forty-two thermocouples disposed about the casing were connected to seven 6 point graphic recorders for temperature measurements. It was thus possible to record average conditions in the whole casing during the heating operation and individual heaters were switched to maintain uniform heating.

When the temperature reached 650° C, the power input was reduced to keep the temperature constant while the casing soaked for three hours. At the end of this period, the heaters were switched off and the casing was allowed to cool to ambient temperature.

The power supply for the process, totalling 510 kW, was taken from a 750 kVA transformer feeding a busbar system at 400V through a 1,000 A switch fuse. Although, in this instance, the heaters were controlled manually, the arrangement is reported to be well suited for automatic control.

For manufacturers dealing with large welded steel structures which need to be stress relieved, the radiant electric method has a number of inherent advantages. Not the least of them is that the operation can be carried out in the manufacturer's works, or elsewhere, irrespective of any limitations imposed by size or availability of an existing furnace installation. GEC offer an advisory service and supply the necessary electric equipment to manufacturers wishing to carry out similar large-scale stress relieving processes.

An Aqueduct is Repaired in Service

To repair an aqueduct supplying water to Manchester, sections were by-passed by pumping. Extreme reliability of pumping plant was essential. Self-priming diesel-driven pumps provided the answer.

THIRLMERE aqueduct, which normally transports 50 million gallons of water daily from the Lake District to Manchester, is some 96 miles long; 45 miles being in pipeline, 14 tunnel, and 37 of cut-and-cover construction. There is a fall of 20 in per mile over the length of the aqueduct, and the rate of flow is about 2 ft per second. The aqueduct was completed in 1894, and has been in continuous service since that date without major attention. Latterly, however, deterioration of the concrete in the cut-and-cover section, particularly in the northern part of the line, has resulted in some loss of water through leakage, and also in the uncontrolled ingress of surface water in some sections. Reconstruction of the cut-and-cover part of the aqueduct has accordingly been undertaken. For this purpose, the daily water flow has been restricted to 20 million gallons, and sections, in excess of ¼ mile in length, are being taken out of service while the water is by-passed through a 30 in diameter pipeline laid on the ground. By this means, one section at a time of the cut-and-cover work, which is approximately 7 ft by 7 ft, with vertical sides and a crowned arch, is emptied and made accessible for examination, testing and repair where necessary.

When planning of the work started, it was obvious that an extremely reliable pumping system, capable of handling 20 million gallons per day, with the highest possible priming efficiency, was essential. It was clear that, with the volume of water being handled, any temporary failure of the pumps due to loss of priming would result in the water level overflowing the stop bulkhead in a short time. With men working in sections of, at times, about a mile in length, danger could arise very quickly. Fluctuations in the volume of water passing down the aqueduct occur from time to time, and normal centrifugal pumps would have been unsuitable in this connection. Even the time lag involved with self-priming centrifugal pumps employing either diffusers or water jets to achieve the priming effect could not have been tolerated.

Two possible systems were studied: axial-flow pumps of large capacity electrically driven from diesel generating sets, and multiple installations of self-priming pumps arranged for direct diesel drive. The size and weight of the axial-flow pump was a disadvantage as the plant would have to be transported frequently from one temporary pumping station to another, and the use of an electric stage between the prime mover and the pump was considered to create a possible source of danger due to failure.

The pumping unit finally selected was the Univac, made by Henry Sykes Limited, Southwark Street, London, SE1. Five pumps are used as the pumping unit on a typical section; four pumps normally handle the flow, and the fifth is a standby. On the Univac pump, an ancillary vacuum pump removes any air drawn into the pump chamber immediately, and pumping continues without any time lag. Thus any danger to the men working in the section is obviated. Each pump has a minimum capacity of 3,500 gallons per minute of clean cold water against a total head of 32 ft, when running at a speed equivalent to an engine speed of 1,500 to 1,550 r.p.m. Ruston and Hornsby type 6YC engines are used to drive the pumps through reduction gearing and flexible couplings.

As originally planned, the work was to be carried out in ¼ mile sections, with the aqueduct being divided by temporary bulkheads; but it has been found convenient, for reasons of access and land ownership, to operate in somewhat longer sections; the longest so far being 5,800 ft.

Operations on a section begin by stripping the cover from the site of the temporary pumping station and access sites to the aqueduct. Concrete bearers are then built for the pumps, and after a part of the aqueduct has been uncovered by an excavator, closely-spaced holes are drilled into the top and the pieces thus freed are lifted off by a crane. For the pumps, 4 ft diameter circles are cut out of the aqueduct to accommodate the suction screens. The pipework on the pump suction and delivery branches is 15 in diameter and incorporates both a flexible and an adjustable section, enabling the pumps to be installed quickly and isolating the remainder of the pipework from the vibration of the pumping gear. The adjustable section consists of a 14 in pipe which is fitted inside the 15 in diameter pipe and sealed to it by rubber wedge rings. A typical time for dismantling, transfer, setting up of six pumps and bringing them into action is 72 hours. When the pump setting and connection is finished, the suction apertures are sheeted over and covered with concrete to prevent pollution of the water.

Downstream of the pump suction openings, a further cut is made in the aqueduct to enable the temporary bulkhead to be placed in position. This has a frame of steel angle construction, with rubber seatings, and is pin jointed to allow it to be fixed securely against the two side walls of the aqueduct by an adjustable cross strut. Two steel panels are then inserted into the frame and locked firmly against the rubber seatings by means of eccentric levers. A similar bulkhead is inserted at the lower end of the section.

When the sealing of the section is complete, the contained water is pumped out with a Sykes self-priming centrifugal pump and the walls are cleaned by scrubbing. This removes a peaty deposit which has accumulated. A 2 in thick silt layer on the aqueduct floor is pumped out, and the complete section is then ready for detailed inspection.

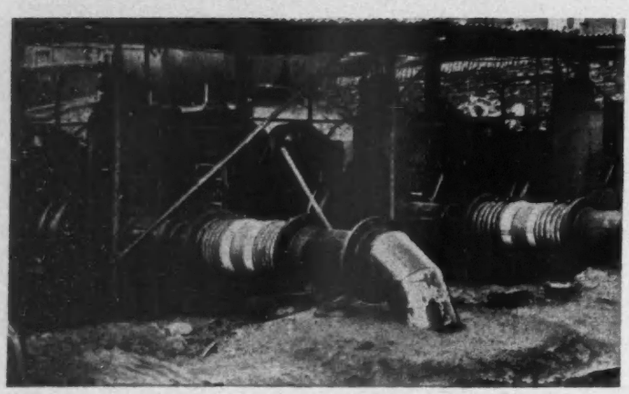
In the northern sections, there is a much larger amount of faulty concrete, and the entire wall of the aqueduct is cut with a modified coal cutting machine. The walls are then completely refaced. In the south, deterioration is far less severe and much less rigorous treatment is needed. Here, the routine is to clean out, inspect, pressure grout, and cut out and make good any parts where this is necessary. A considerable degree of flexibility is employed in treating the affected parts. When the deterioration is fairly deep, the affected piece is cut out, and a tube is inserted to relieve the water pressure outside the wall while a quick seal is obtained with a rapid setting compound such as "Quicksocrete." When the seal has been made, Fondu concrete may be used to strengthen the work, the remainder of the concrete being of 2 : 1 : 1 mix. Further grouting can be carried out through the tube in the wall if necessary, a plug being inserted in the end on completion.

For pumping out the sludge accumulation, Consolidated Pneumatic compressed air sludge pumps are used, the air being supplied by CP rotary vane compressors powered by Rolls-Royce engines, sited at the various access points cut into the aqueduct.

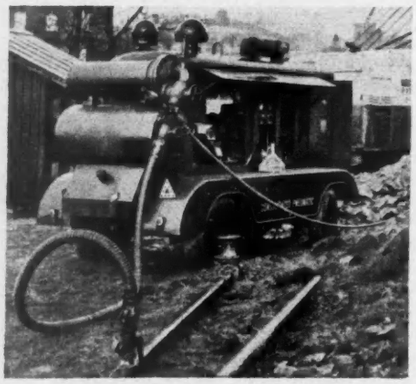
While reconditioning is in progress the floor of the aqueduct is being reinforced by the laying of 4 : 2 : 1 concrete, 4 to 6 in thick. This concrete is mixed on the surface in a Benford mixer, with a Ruston-Bucyrus 22 RB crane and trucks for handling aggregate and other materials. Transport of mixed concrete through the aqueduct is in small battery-operated Brush trucks. Pipe sections are transported from one section to another by means of a Fordson tractor-hauled mobile tubular framework designed by the waterworks engineers, pipe handling on the sites being carried out by a Smith 10 ton crane.

Because the work is spread out over a considerable distance, above and below ground, with innumerable crossings of public roads, the organisation of movements and communications is complicated. Pye short-wave radio is used for communication, with a set installed at the site office, another at the pumping station, and a third in one of the Land Rovers used for general intersite transport.

Until the various parts of the aqueduct are uncovered and examined, it is impossible to determine exactly what work is necessary, and tendering by contractors would have been extremely difficult, if not impossible. It is mainly for this reason that the reconditioning is being carried out by the owners of the aqueduct, Manchester Corporation Waterworks.



(*Left*) *When the pumps are in position on their temporary foundations, the connections to the aqueduct are sealed to prevent pollution.*



(*Right*) *Power for sludge pumping is provided by portable CP compressors.*

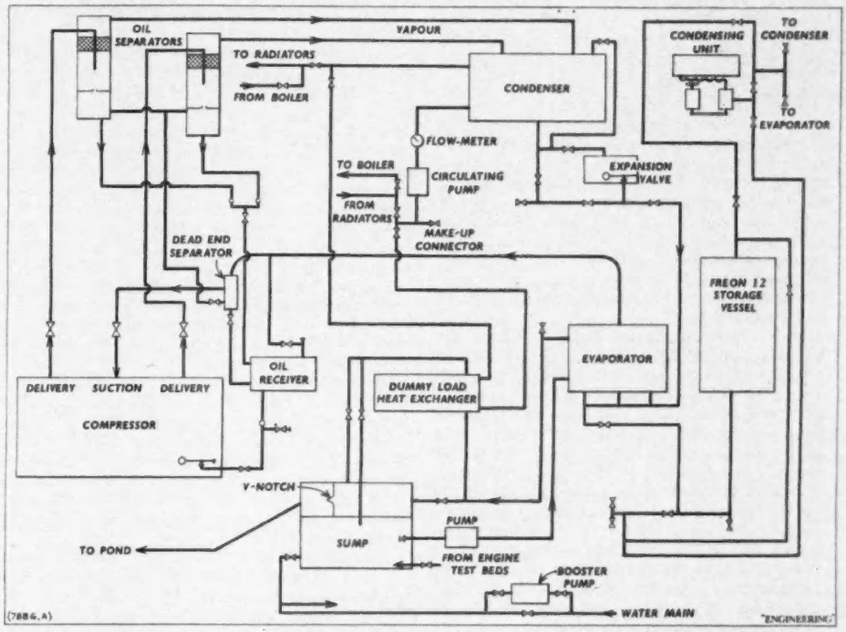
Heat Pump will Give Design Data

Davey, Paxman and Company of Colchester have built an experimental heat pump to gain experience in design of such plant for space heating. Existence of a source of low grade heat from diesel engine test beds, coupled with the thermal storage of the engine cooling ponds and a building requiring space heating of the order of 1 million Btu per hr, has provided the background opportunity.

The design is based on an electrically driven mechanical compressor, using the refrigerant freon 12 as a heat transporting medium, and shell and fintube evaporator and condenser for the freon-water heat transfer. Engine type radiators with electric fans are supplied with hot water from the heat pump condenser by means of a circulating pump. This enables the radiator water temperature, which is variable, to be kept to a minimum, and gives a reasonably high performance energy ratio. Fully automatic control is employed to modulate the compressor output and produce in the condenser a radiator water temperature which will just balance the building heat losses. Secondary control limits the radiator circulating water temperature to approximately 130° F, thus preventing the condenser pressure from becoming too high and overloading the compressor. There is provision in the controls for manual adjustment to cater for wide seasonal variation.

The compressor is a 12 cylinder machine which normally runs on 8 cylinders, but has automatic valve lifting gear which enables it to operate on 4, 6, 8, 10 or 12 cylinders according to the signal from the controller.

As shown by the accompanying diagrammatic layout, the plant has numerous extras which are not required in a normal installation. The extra equipment has been included to enable trials to be carried out with the plant on dummy load. When this is being done the building heating circuit can be supplied with hot water from sectional boilers if necessary.



Using low grade heat from diesel test beds, this Davey Paxman installation is designed to provide data on use of heat pumps in space heating.

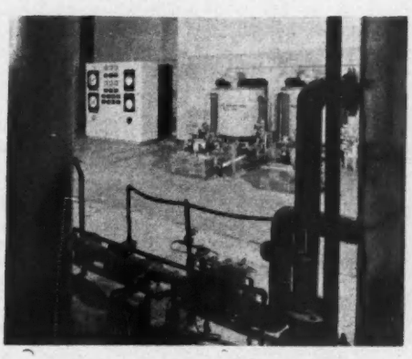
Saving Money by Wasting Heat

Tidy sums could be saved by buying summer clothes in November and winter clothes in March, taking advantage of low prices during conditions of low demand. Unfortunately, the customer would alternately freeze and suffer apoplexy through being out of step with nature and with normal buying habits. Block storage heaters are designed to circumvent the difficulty by damping the waves of supply and demand.

Electricity companies charge lower prices during periods when nobody wants their product in order to encourage consumption. The difference may be considerable, a typical example being 2*d* per unit of electricity during peak hours but only 0·85*d* at night. Block storage heaters consist of a time-controlled electrical heater immersed in a heat-storage medium. To take advantage of low prices the heater is turned on at the wrong time from the consumer's point of view, that is at night. It is therefore necessary to provide the storage block in order to even out the temperature fluctuations. Unlike ordinary heating, the installation operates at essentially constant temperature, the magnitude of the temperature fluctuations depending on the heat storage capacity and rate of loss from the heated space. Although the total power consumption of a stored-heat installation may be 20 per cent higher than the consumption of daytime heating, the total cost will be some 35 to 40 per cent lower as a result of the price difference.

Thermodare, one of the earliest makers of block storage heaters, produce a range from 1 to 3 kW rating. There are six different models covering sizes from 22 in by 12 in by 23 in high to 32 in by 12 in by 31 in high. General Electric produce their Nightstor range, a 1 kW model of which is only 21½ in high and is designed to fit under the sills of low windows now fashionable. Ekco's range of Thermostore heaters provides models from 1½ to 2½ kW rating, while Tyrad Electric have introduced their SS model storage heater which embodies safety features to prevent overheating due to inadvertent masking.

Automatic Water Treatment



At Willington A power station, near Derby, the feedwater treatment, which is carried out in a plant supplied by the Neckar Water Softener Company, is controlled by a system which is so far unique in the United Kingdom. The control system, which is novel in that flow and pH control are coordinated by the use of averaging relays, was supplied by Honeywell Controls.

Using town's water for boiler feed, the treatment plant operates on a two-stage system. Water is first softened in a vase exchange softener and then dosed with an automatically-controlled flow of acid to decompose the bicarbonate present. It then passes to a degassing tower where the free carbon dioxide is liberated.

A trace of carbon dioxide remains in the water, together with a slight excess of acid, and alkali injection follows to bring the water to the required pH value before it passes finally to storage tanks and the evaporators.

The rate of acid dosing is controlled by the average of the signal from the liquid level controller and the controlled air output from the pH controller, and the alkali dosing is governed by the average of the flow transmitter signal and the controlled air output of the second pH controller. For the acid system a second relay, manually adjustable, allows the acid dosage rate to be varied to suit changes in the total alkalinity of the untreated town's water. It is thus possible to reset the system to suit the feedwater from different sources in the locality.

In operation the new control system has been found to keep the pH value to within 0·2 pH.

On the Shelf

By Frank H. Smith

I feel quite sure that the President of the American Rocket Society will not mind if I "lift" the complete editorial he has written in a recent issue of *Astronautics*. It runs:

Like the sorcerer's apprentice popularised by Disney, the modern space technologist finds himself all but submerged in a flood of printed matter ranging from space cadet manuals to unadorned differential equations. Spoken words on space pour over him from many sources. Every day at several places in the nation professional societies hold meetings, often with parallel sessions, vying with each other to embrace the omnifarious subjects of space technology.

In these noisy circumstances, it behoves the members of the American Rocket Society to speak only when they have something to say. The chairmen and members of our numerous technical committees bear the responsibility for creating meetings only in response to a genuine need. After initiating a meeting they should insist on thorough (and prompt!) review of the submitted documents and accept only those judged sufficiently significant, sound, clear, and brief. This process will of course disappoint certain prospective authors, but it will earn the appreciation of many busy professionals who do not have time to refine the gold from the dross, and more importantly it will earn for the ARS a deserved reputation for technical excellence.

We realize that execution of a policy of careful discrimination among scientific papers is difficult. Our less technical communications with laymen, youths, and ARS luncheon guests must also be monitored to the credit of the Society. As Gilbert and Sullivan put it, "A policeman's lot is not a happy one." I am persuaded, however, that discipline exercised by the technical committees and program chairmen will in the long run pay valuable dividends for the ARS.

There's a firm named Leslie and Company Limited, Peel Street, Kensington, London, W8, who, it seems, count the present front of Buckingham Palace, the AA Headquarters and some whacking great flats at Newcastle among their memorials and they now produce a house magazine called *The Leslie Way*. It's a good first number with articles on walls (of Wallsies fame) and Hugh Fraser among others.

Schweppervescence has burst into Pelicans with *Management Survey*, by Sir Frederic Hooper, at 3*s* 6*d* (Pelican A474).

A new series started by the Australian Aeronautical Research Laboratories is entitled "Human Engineering Report." This is one of those unpublished things that are the very devil to get for retention but borrowing should not be so difficult. Anyway the application is so specialised that I doubt if any of your people will want it (Pilot Opinions and Practices on the Approach to Landing).

With half the country imitating the dove from the Ark, a timely *Map Bulletin 13* comes from Edward Stanford: "A list of Maps and Atlases published by many official Foreign and Colonial Surveys." Most of the maps are, admittedly, technical types but there is, for instance, the odd gem such as "Topographical and Bus Route Map" of Malta at 2*s* 6*d*.

Joy-Sullivan Limited of Greenock (whose acquaintance I have not, hitherto, made) formed an Air Power Division last year (no, no, *not* aircraft—pneumatics) and to embellish this they now produce a newsletter *Air Power News*. To be placed on the mailing list, simply write to Joy-Sullivan Limited, Air Power Division, 7 Harley Street, London, W1.

A handout from a Pasadena firm called the Digitran Company tells me of the Digiswitch. The more you say it the funnier it sounds.

Man-Machine Systems

Research Techniques in Human Engineering. By ALPHONSE CHAPANIS. *The Johns Hopkins Press, Baltimore, Maryland; Oxford University Press, London.* (48*s*)

Psychologists and physiologists have been studying human performance in the laboratory for very many years, but it was not until the First World War that any serious attempts were made to investigate problems of human performance in industry. Then concern over fatigue in munition factories caused them to spread their activities into industry under the auspices of the Industrial Health Research Board. Anyone who reads the long series of reports which were published between the wars by the board will be impressed by three things. First, the major part of the work was done in industry itself. Secondly, owing to the experimental design it is not always possible to be quite certain whether the differences found were due to changes in the experimental condition or whether they were fortuitous. Thirdly, relatively little statistical treatment of the results was carried out. This is not intended as a criticism of the very fine studies done by those who worked for the Industrial Health Research Board, but at that time many of the problems of conducting experiments on human performance were unrecognised and the statistical methods of treatment of the data were in the process of development.

The Second World War gave great impetus to the study of human performance by bioscientists and this has continued to develop in the United States since the war under the name "human engineering" and in Europe under the name "ergonomics." There has, however, been a marked change between the investigations carried out since the war and those which took place between the wars. The wheel has turned full circle and research investigations are again conducted mainly in the laboratory rather than in industry itself; moreover, they have been mainly for military purposes. The rapid development of this work has led to the recognition of the difficulties in carrying out investigations with human subjects and to the development of new methodologies which attempt to reduce to a minimum the variables introduced by the use of human subjects and at the same time there has been a great advance in the statistical treatment of results, particularly in the results from small groups of subjects whose performance is non-parametric.

Experimenting with human performance poses a number of peculiar problems which are not to be found when carrying out experiments on inanimate materials; these peculiar problems derive particularly from the wide variability of the people who may be used as subjects in the experiments. Thus it is a great deal less easy to be certain that the changes which have been found, as a result of experiments carried out to test the effect of different variables, are in fact due to those variables. For instance, a change in performance when moving from one condition to another may be due to learning or to previous experience which may be more beneficial to one condition than to another; or apparent improvement in performance between one group of individuals and another may be due to the superior qualities of the group giving the best performance.

These and other similar problems cause special difficulty to the bioscientist and they must all be taken very seriously into consideration when conducting research using as subjects individuals of different sex, size, age, mental and physical ability and with different degrees of motivation. Thus it is that the physical scientist or the engineer who finds it necessary to carry out experiments on human performance may run into trouble if suitable precautions are not taken and if the experiments are not planned with all the difficulties in mind. It is probably true that the previous training and experience of these physical scientists in methods of experimentation does not equip them to anticipate the many difficulties which may arise. The simplest example of experiments of this kind would be the comparison of two methods which have been motion studied. Unless suitable precautions are taken and suitable statistical techniques are used the person conducting the tests cannot be *sure* that the results are in fact due to the change of method and may not have been due to the way in which the test was conducted or purely to chance.

Many of the problems of this kind are dealt with in a new book which has come from America in which many, but by no means all, problems of conducting experiments on human performance are considered. For an English reader there are often difficulties in appreciating American technical books. If a book is written in French, for instance, differences in approach would be put down to the difference between the Anglo and the Gallic temperaments, but because the British and the Americans use approximately the same language one is inclined to assume that American thought processes are similar to British. As a result one comes to expect from an American book a preciseness of presentation and a clarity of thought that one would expect from a similar book if written in this country. This difficulty is particularly marked with the book at present under review.

To a European reader the book may well get off on the wrong foot from the outset since on the first page of the preface, in discussing the term "human engineering" (which, to his credit, the author does not like), one of the alternative names mentioned is "ergonomics." The statement is made that this "substitute" for human engineering seems not to have taken hold. This may certainly be true in America, but to suggest that this is so elsewhere when there is an International Ergonomics Association (which is supported by a number of Americans) and a journal with the title of *Ergonomics* is to put it mildly, rather unfortunate. Human engineering, as such, developed in America from the very fine work done by experimental psychologists in the military field, and in spite of attempts to broaden the definition this appears to have been on the whole the main preoccupation of human engineering up to the present time. (McCollom I. N., "Psychologists in Industry in the United States," *American Psychologist*, vol. 14, p. 704). The result is that this book has a very strong military flavour from the psychological point of view. Most of the examples given are drawn from the military field; physiology and all its attendant problems are almost completely ignored. It will, therefore, be of interest in a rather narrower field than it would have been had all the research techniques which are involved in ergonomics been dealt with.

In addition to matters already mentioned, a major difficulty in assessing the real value of this presentation follows from the feeling that the author does not seem to be able to make up his mind for whom he is writing. The book purports to provide a general background of information for the student of human engineering which should be of interest to those actively engaged in industrial engineering, operations research, system engineering, experimental psychology and scientific management to quote the dust cover and yet the book is written in such an elementary style that it is intensely irritating to read.

Although presumably it is intended to be read by intelligent people who must have received a pretty extensive training, probably to a higher degree level in scientific disciplines other than psychology and physiology, its level of presentation, though not of content, would appear to be suitable for people of about GCE standard. For instance, in discussing the preparation of a frequency table, the author instructs us to cross through every four tallies with a fifth tally "so that they may be counted more easily," a technique that most children of fourteen will

already have learnt. Or to give another example: "Just looking at the word *psychophysical* gives you a clue about what it means. It is made up of two parts, *psycho-* and *-physical*, and thus . . ." is what *Punch* used to call a glimpse of the obvious.

There is thus a feeling throughout that the author is underrating the intelligence of the reader and is talking down to him. This, however, is a characteristic of many American books.

More than 50 pages are devoted to elementary statistics of a type which applies equally to the physical as well as to the behavioural sciences which, one would have thought, would have been familiar to most of the people to whom the book purports to be directed. The behavioural scientist is dealing very often with small samples of non-parametric data; although the parametric *t* list and *F* test are very elastic, it is often more appropriate to use statistical tests which are different from those which can be used when fairly large samples, normally distributed, are available. It would seem that in any book dealing with experiments on human beings, this point ought to be made particularly clear, and tests such as chi-squared, Kendall's π, the Mann-Whitney U test, the Friedman two-way analysis of variance and the Wilcoxon signed-ranks test, should have been dealt with in detail. Also dealt with at some length is material which is to be found in any good book on motion or method study and one wonders whether it is confusing the issue to introduce it here at such length. Useful though the methods of direct observation are it is not until nearly 150 pages have been passed that the real core of the book is reached where the methods of the bioscientist differ radically from those of other scientists.

An interesting approach, which could have a wide application beyond the behavioural sciences, is the concept that the "engineer can discover many important things about man-machine systems by observing malfunctioning ones"; that is, by studying accidents or near accidents. A chapter is devoted to this subject and is useful for its discussion of the Critical Incident Technique. These studies may give a starting point from which research can begin.

In dealing with experimental method the author deals with some of the problems involved in designing experiments both for making simple comparisons or when a number of variables are involved. Devices are described to overcome human variability, learning, and so on, and these include the use of matched groups or matched subjects, making each subject act as his own control and latin square designs. The importance of realism in the experiment and the many problems of selecting and motivating the subjects are dealt with in detail. The last two chapters of the book examine psychophysical methods and articulation testing methods. The former are of particular use in the laboratory and should form part of the training of the psychologists who are most likely to use them; in the latter we have moved from the general to the particular and so far as industry is concerned, there seems no special reason (other than padding) why this particular area should have been chosen. Thus, while both these chapters are interesting they are likely to prove of value only in a very limited industrial field, if at all.

It is essential that anyone who is going to be concerned with studies of the performance of people should have a knowledge of the material set out in this book. It should, however, be realised that this book does not contain, by any means, all the answers. The methods described are primarily those of the laboratory and the very special difficulties which occur when one is compelled to carry out tests on the shop floor are hardly discussed.

The author recognises the difficulty of extrapolating from the laboratory to real life but has very little to say about the validation of laboratory results at the shop-floor level. This omission does of course follow from the different standards of performance which are expected from the military as compared with the shop-floor operatives. A laboratory experiment is quoted, for instance, in which it is shown that giving knowledge of results would increase output by 25 per cent. This finding is, of course, true under the conditions of this particular experiment but it does not necessarily mean that allowing operators to know how many parts they are making in a factory is going to have this sort of effect, since there are so many other variables which may influence output besides knowledge of results. In fact, under certain conditions it may even have an adverse effect, since it is known that operators will set themselves norms and if they are able to tell whether they are likely to exceed the norm, output may actually slow down. Merely to say that it is more difficult to conduct shop-floor experiments is completely begging the question.

No discussion of experimental method in the human field, as applicable at any rate to the study of work in the non-military field, can therefore be complete without a very full discussion of the methods which are steadily becoming increasingly used for overcoming the many difficulties inherent in the lack of control over the experimental variables which is necessary when experiments have to be carried out on the shop floor.

When all has been said it must be recognised that this is the first book to deal specifically, although not comprehensively, with research techniques in fitting the job to the man; as such it is the only source (albeit a rather costly one) available at present to those who need to know about the methods which should be used and the precautions which should be taken—if they can separate the wheat from the chaff.

K. F. H. MURRELL

New Books

Analysts Pocket Book. By J. R. MAJER. *Butterworths Scientific Publications.* (17*s* 6*d*)

A spiral-backed reference book containing all the quantitative information likely to be needed in the laboratory by the student or by the routine analyst.

Materials and Techniques for Electron Tubes. By WALTER H. KOHL. *Reinhold, New York; Chapman and Hall, London.* (132*s*)

A completely revised edition of the author's *Materials Technology for Electron Tubes*, published in 1951, intended as a reference tool for development, laboratory, and technician use. The revision of the text was aided by consultation with a large sample of competent users of the earlier edition.

Nuclear Power Year Book 1960. 3rd edition. Edited by W. CALDWELL DAVIDSON. *Rowse Muir Publications.* (52*s* 6*d*)

Delays consequent upon the printing strike have been taken advantage of to make further revisions of the text, although realignments have already dated some of the commercial information. The annual review of the industry is followed by reference sections on physics and materials, world authorities, isotopes, company addresses, trade names, a buyers' guide, and an enlarged who's who.

Steelmaking for Steelmakers. By A. JACKSON. *The United Steel Companies Limited, 17 Westbourne Road, Sheffield 10.* (40*s*)

Originally published in serial form in *Man and Metal*, the journal of the Iron and Steel Trades Confederation, the material in this book is based on lectures presented to evening schools and technical societies, and aimed at the men who actually make the steel: melters, ladlemen, teemers and others.

Progress in Dielectrics. Volume 2. Edited by J. B. BIRKS. *Heywood.* (55*s*)

The second of a series of annual volumes, made up of six critical reviews of the present state of knowledge in selected aspects of dielectrics, including properties of glass and ceramics, and a review of irradiated polymers by Black and Charlesby.

Our Mineral Resources: An Elementary Textbook in Economic Geology. By CHARLES M. RILEY. *Wiley, New York; Chapman and Hall, London.* (56*s*)

An introductory chapter on the principles of ore deposition is followed by chapters on specific metals and on ground water and non-metallic minerals. Maps of areas of occurrence and photographs of the materials are given.

Main Lines Across the Border. By O. S. NOCK and ERIC TREACY. *Thomas Nelson and Sons Limited.* (25*s*)

The two authors have brought words and pictures respectively together to produce an account of locomotive running on the three main routes from the south, up to the fringes of industrial Scotland.

Applied Heat for Engineers. By J.-B. O. SNEEDEN. 3rd edition. *Blackie.* (25*s*)

This new edition has an added chapter to cover refrigeration, of particular interest to marine engineers. A treatment of the theory and basic principles is followed by specific sections on steam plant, blowers and compressors, and gas turbine plant.

Elements of Radio Engineering. By H. I. F. PEEL. 2nd edition. *Cleaver-Hume Press.* (13*s* 6*d*)

A textbook primarily intended for City and Guilds' Radio and Telecommunications (Principles) courses, this also largely provides for the relevant IEE, Brit.IRE, PMG, Ministry of Civil Aviation, and National Certificate requirements.

Laboratory Technicians and Assistants. Issued by The Central Youth Employment Executive. Choice of Careers No. 94. *HM Stationery Office.* (2*s* 6*d*)

Details of day-to-day work in different kinds of laboratory, personal qualities and qualifications required, methods of training and examinations, and entry and prospects.

Applied Mechanics. By P. D. COLLINS. *Longmans.* (18*s*)

The author has covered the main topics necessary for students taking the final year of the part-time course of study leading to the ONC Applied Mechanics examination. The text is illustrated by many worked examples and is intended for independent study.

The Reviewer

Mr. K. F. H. Murrell, M.A., F.R.P.S., is in charge of the Unit for Research on Employment of Older Workers in the Department of Psychology, University of Bristol. He prepared for ENGINEERING the series of articles "Data on Human Performance for Engineering Designers," now available as a reprint.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Ptfe. POLYPENCO LTD., Tewin Road, Welwyn Garden City, Herts. Leaflet gives sizes and properties of new thin wall electrical sleeving, and of other ptfe products made by this company.

Glass Reinforced Plastics. RUBERY, OWEN & CO. LTD., Wrexham, North Wales. This firm offer a service for production of reinforced plastics components. Leaflet describes background to organisation.

Die Steel. HADFIELDS LTD., Sheffield, 9. Leaflet on "Hecla 174" alloy which is a 0·4C-1·0Si-0·5Mn-5·0Cr-1·4Mo-0·9V-steel with good resistance to thermal crazing.

Nimonic Alloys. HENRY WIGGIN & CO. LTD., Millbank, London, SW1. Engineering data book has been brought up to date and includes long term creep curves for alloys 80A and 90.

Titanium. IMPERIAL CHEMICAL INDUSTRIES LTD., Millbank, London, SW1. Two more of a series of booklets on the company's titanium products. Part 2: 60 pages on physical and mechanical properties. Part 4: 28 pages on fabrication.

Aluminium Casting Alloys. ASSOCIATION OF LIGHT ALLOY REFINERS AND SMELTERS LTD., Albemarle Street, London, W1. Mounted data sheet to replace 1955 issue.

Resins and Glues. LEICESTER, LOVELL & CO. LTD., North Boddesley, South Hants. 16-page guide to synthetic resins and glues made by the company.

Social Research in European Industry

Social research in industry still meets every kind of reception. Some firms keep it out for fear such activities "will put ideas into their heads." Perhaps as many as half of those who hold an opinion believe that social inquiries have some value.

A STIMULATING survey of social studies in the industrial world of Western Europe, including the United Kingdom, has appeared, revealing a very mixed up situation.

The European Productivity Agency organised a Conference of heads of research institutions and research workers from nine West European countries, including Britain, in Paris, last July. The object was to find answers for the various questions about the function of the social researcher and the problems he encounters in trying to analyse and explain industrial problems.

This Conference followed on the earlier work of EPA on problems of "fitting the job to the worker." The report of the meeting, which has just been published by the Organisation for European Economic Cooperation, is divided into four parts. The first gives a factual account of the composition and work of the Conference and comments on the present state of social research applied to industry in the various participating countries. The second part deals with some problems relevant for the psychologist and sociologist working in industry. The third section tries to answer the question—What practical use has social research for industry?

SUPPORT

And the final part of the report tries to assess the role of international organisations, such as EPA, in the development of social research and its application to problems of interest to employers and workers in industry in all European countries. The first question tackled by the meeting was—How to obtain the interest and support of both sides in industry, employers and workers, for social research? The answer is not very encouraging. Few companies at the present time seem to welcome social research, although the response is influenced to some extent by the way in which the request to be allowed to do research is made. The reasons for this lack of response vary a great deal. But the outstanding one seems to be that industry is reluctant to cooperate in social research because it knows little or nothing about it. This, in turn, raises the difficult problem of how far the results of research should be made widely known.

Should the object of every piece of research be to publish a report? Or, should certain results be kept confidential? This is a dilemma which every research worker knows only too well. Either he can obtain information which he cannot publish, or the information he receives is of such general nature that no one is interested in it when he does publish it. In this case, the conference agreed that no research should be undertaken without previous agreement by both employers and trade unions that the results would be published, though anonymity would be preserved as far as possible.

Another problem is how to make the results of research widely known. There is little purpose in carrying out an intensive piece of research if no one ever hears about it. The conference thought that the essential point was that there should be personal contact between social researchers and industry. This question of a meeting between industry and research led on to the further question of the respective roles of the academic researcher and the company expert or consultant. A case study, prepared by Mr. Trist of the Tavistock Institute of Human Relations, led to a discussion which decided that the problem is not a dilemma.

From this rather theoretical discussion the Conference turned to the practical problem of what industrial psychology and sociology have to offer for industry. What is their practical value? In a general way one of their functions is a process of what someone called "de-mystification." It was felt that psychology and sociology have already achieved some results which are very relevant for industry. Psychologists have generally been concerned with personnel problems. Every foreman knows that dealing with people is much more difficult than dealing with machines. In the Lancashire phrase "There's now't queerer than folk." The job which gives great personal satisfaction to one man will be monotonous and boring to another, and a third will find that he is quite unable to tackle it.

The newer task of the psychologist and sociologist is what is nowadays called "human engineering." For this the problem consists rather in finding out how to make the job fit the man—that is, fit any man. Clearly, if "human engineering" is successful then the work of selection becomes less important. Apart from this the human engineers are busy looking at the requirements of production for a particular task in terms of noise, heat, mental stress, and so on.

ELTON MAYO

A third trend discussed at the conference was the way in which psychology focuses its interest in industry on the group, rather than on the individual worker. The beginnings of this movement may be traced to early experiments by Elton Mayo. The discussions were in very general terms. From this, the next step was to consider the object of research.

Social research, it was felt, had been "gorged with facts." It was felt that what was needed was a priority list of problems to be systematically investigated and a critical definition of the tools that could be used in carrying them out. Something is being done to solve these problems in the United Kingdom by the Department of Scientific and Industrial Research, and in France by the Centre Nationale de la Recherche Scientifique. It was felt that a great deal still remained to be done and that a body such as the European Productivity Agency might well have an important function to perform. In the last few years projects and activities of various kinds have been undertaken by the agency. Its research activities in the field of human sciences are guided by two principles—"the inter-disciplinary approach and the joint employer-worker approach."

The second part of the report is most interesting to the individual in industry who wants to know what social research is all about, and what use it is likely to be for him. This part contains accounts of what is being done in various countries. In some cases not very much more than occasional meetings for the exchange of information were arranged. This happened, for example, in Belgium, where responsibility for drawing up research programmes has been placed in the hands of a joint committee consisting of representatives of employers' associations, trade unions, and university teachers.

Arrangements have been made for the setting up of full-time research fellowships, to work with the various research centres. In France, considerable progress has been made in social research over the last few years. Studies have been carried out in industry, agriculture, commerce, and administration. These are conducted either by research workers attached to the universities, or the Centre Nationale de la Recherche Scientifique, or by individual psychologists, industrial sociologists, and industrial experience.

consultants, who wish to extend their professional

Two kinds of research are being carried out. The first are purely descriptive studies aimed at assessing the existing problems, for example, the attitudes of steel workers to technological change. Secondly, research concerned with means of finding an answer to these problems and not simply describing them. Research in economics and psychology has so far centred round the "working day," or, in some cases, "working hours." Today, the dominant idea in the study of social relationships is that of "working life." That is, the whole time devoted to work by an individual, throughout his life.

Two studies on trade union action within the firm are being carried out in France. The first by M. Sellier, Professor in the Faculty of Law at Aix-en-Provence, was concerned with wages and labour relations. As would be expected, it revealed certain problems of what is called "communications." In other words, a large number of people just did not know what was going on. Another study, in this case on behaviour, was carried out at the Grenoble works of the Etablissements Merlin et Gérin to find out the attitudes of various occupational groups towards management and trade unions.

Other pieces of research carried out in France, described in the report, concerned the behaviour of the young industrial worker, the attitude of white-collar workers and minor civil servants to different situations. Another study was on the adaptation of agricultural workers to urban industry. This was carried out in the Bordeaux area and involved interviews with 100 workers who had recently left the land. From the examples given in the report it is clear that a great deal of attention, although somewhat scattered, is being given to sociological research in industry in France.

SPONSORS

In Italy, a great deal of work is going on in this field. For the most part, the research workers are not attached to the universities, but to centres, such as that in Genoa which is supported by the City Council, and another in Bologna. The interest taken in sociological research by big industrial firms in Italy has increased considerably in the last few years. To mention just a few, Montecatini, Olivetti, Fiat, Pirelli, and others, all have a considerable interest in research of this kind. In addition, the big state-owned concerns, IRI and ENI, are both sponsoring research among their workers. Not everyone, however, is wholeheartedly enthusiastic about it. To quote the report "Opinions are fairly well divided between those who think such enquiries are useful and those who think they are not." And in another firm, sociological research was objected to on the grounds that "this would put ideas 'into their minds.'"

For the United Kingdom, a report by F. E. Emery, of the Tavistock Institute of Human Relations, gave an account of work carried out by the National Institute of Industrial Psychology and two research teams of the Medical Research Council's Industrial Health Research Board and the Industrial Psychology Research Groups at Cambridge before the Second World War. Since 1946, the character of industrial psychology in Britain has been largely moulded by activities of the war period. The organisation of research now ranges from work carried out by university staffs in their spare time to special research appointments within the university departments, post-graduate research units, Medical Research Council units attached to a university, and fully independent research bodies, such as the NIIP and the Tavistock Institute. On the whole, it is true to say that social research in Britain has progressed very considerably since the war, and that the main problems for the future may lie in coordination of the work carried on rather than in any lack of awareness of its value among industrial leaders.

Marketing

£2½ Million Hydro-Electric Contract

HIDROELECTRICA ESPANOLA has ordered hydro-electric generating plant worth £2½ million from ENGLISH ELECTRIC.

To be installed 120 miles south west of Madrid, the plant was tendered for with some keenness by English Electric's European rivals.

The power stations will be the first to be built on the Spanish part of the River Tagus. The equipment is to go into two stations, which will have a combined output of 400,000 kW.

The delivery of the equipment begins next year. Three 108,000 h.p. turbines and three 83,333 kVA alternators are being built for one station and four 36,000 kVA alternators for the other. This part of the contract will be carried out at the Netherton Works, Liverpool. Associated 230 kV and 138 kV airblast switchgear for distribution will be made at the English Electric works at Stafford.

Key US Waterworks Order for Scots Pioneers

An important $500,000 (£179,000) order for the Denver, Colorado, BOARD OF WATERWORKS COMMISSIONERS, has been received by the Kilmarnock, Scotland, firm of GLENFIELD AND KENNEDY.

The order is for a major installation of Micro-straining units of ten ft diameter by ten ft wide, for the initial stage of a proposed 100 million gallons a day plant.

The Micro-straining process, pioneered by Glenfield and Kennedy, is established in the United Kingdom where it was a valuable step forward in solving filtration problems at low cost.

The Denver contract, with another recent order placed through the company's agents in Eastern Canada, MCCALL & Company, is strong evidence of the acceptance of micro-straining in North America.

With a flow of 90 million gallons a day, the Ashford Common Works, of the London METROPOLITAN WATER BOARD, has, at present, the largest Micro-straining plant in the world. It has 24 ten ft diameter by ten ft wide machines.

Installations of up to three times this size are being considered in the United States. Some months ago the first Micro-strainers were sent off for use in Japan. It is against these export potentials that the most recent order assumes value beyond its half million dollars.

Steel Strip Contract with East Germany

New Hardening and Tempering lines coming into use at the works of FIRTH CLEVELAND STEEL STRIP Limited, will enable the company to meet a new contract to supply strip to Eastern Germany without delaying supplies to home customers.

The company, a member of the Firth Cleveland Group, reached agreement on the contract with the steel purchasing organisation of Eastern Germany after participating in the Leipzig Trade Fair. Specified tonnages are to be supplied under an agreement covering several years.

Pump Tour of Scandinavia

A three week tour demonstrating their Flowmaster vertical centrifugal pump has been undertaken by J. H. CARRUTHERS AND Company, the East Kilbride, Glasgow, pump and crane manufacturers.

After touring Norway, Sweden, Finland and Denmark, the pump, which is already finding a substantial market in British shipyards, will be shown some time later for a fortnight in Holland and Belgium.

The travelling team will take along a diesel driven generator and the demonstration pump and piping, making the whole operation independent of local supplies.

Six into Seven Moulding Machinery Agreement

Agreements by United Kingdom firms giving them a foothold in the European Common Market and moves by American firms to do the same or safeguard their future in the British led European Free Trade Area are common enough.

Details are now available of a move in a less common direction. The German firms LEONH HERBERT and PAUL TROESTER have concluded an agreement with the Peterborough firm BAKER PERKINS which allows it to manufacture and sell their complete range of rubber processing and moulding machinery.

Leonh Herbert, of Frankfurt, specialise in tyre building and curing machinery. They are the only designers outside the United States of bladder-type tyre curing processes for new and retread work.

Paul Troester, of Hanover, supply standard rubber processing equipment—including mills, calenders and extruders.

The new agreement will allow Baker Perkins, who have for many years provided mixing and materials handling equipment to the rubber industry, to supply a complete processing line throughout Britain and the Commonwealth.

The Fate of Coastal Shipping

The reduction of the coastal shipping fleet from 600 vessels to 500 over the past three years lends point to the reminder from Sir Donald Anderson, the chairman of P & O, that Great Britain needs road, rail and coastal shipping but that if it is to have all three it must enable each to do what it can best.

Sir Donald observed that the railways, by lowering charges where they were competing with coastal shipping, could run coastal shipping out of business without much increasing their own losses.

"Yet strategically we all know that small ships would be of vital importance in any future war," said the P & O chairman. He was addressing the Institute of Transport.

On the same theme, Mr. Desmond Pelly, chairman of the coastal shipping section of the CHAMBER OF SHIPPING, has recently said that coastal shipping has not asked for help from the Government. But "the way the railways are being subsidised we may have to be subsidised to survive."

Lively Rise in British Tractor Exports

Tractor exports from the United Kingdom were 50 per cent greater in the first quarter of this year than in the first three months of 1959. Tractor exports January to March this year were 38,579.

Their value rose from £20·4 million to £30·2 million.

Figures released by the AGRICULTURAL ENGINEERS ASSOCIATION show that American farmers are now buying three times as many British made tractors. In this year's first quarter they bought 4,571—against 1,496 a year ago.

This still does not make them our best customer, Australia bought 4,830 tractors in the same three months, compared with 2,526 in last year's first quarter.

Executive Class Air Cup

Further support for the use of aircraft for business travel in and from the United Kingdom comes from the Royal Aero Club who are running a Business and Touring Aircraft competition at Shoreham Airport, 20-21 May.

The GENERAL ELECTRIC COMPANY, which for four years has given the Osram Cup to a class event in the National Air Races, is this year giving the award to the overall winner of the competition at Shoreham.

GEC, the leading supplier of aircraft galley equipment and an important figure in airport lighting, is also giving £525 of the total £925 prize money.

Three classes of entry have been laid down. They are:

Single-engined touring aircraft of one or two seats, not exceeding 2,204 lb all-up weight.
Single-engined business and touring aircraft with more than two seats, or exceeding 2,204 lb but not above 12,500 lb all-up weight.
Multi-engined business and touring aircraft not over 12,500 lb.

Efficiency will be judged on performance over a 400 mile course, starting and ending at Shoreham with turning points in Kent, Northants and Bristol. This will take into account not only air speed and fuel consumption, but also seating and baggage capacity.

On the second day there will be tests of shortness of take-off and landing, engine starting, ground manoeuvrability and comfort and equipment.

Shareholders' Plan for US Airline

CAPITAL AIRLINES shareholders' association, which is mostly made up of company employees, has put forward a plan for saving the company from foreclosure proceedings. The legal action has been taken by VICKERS-ARMSTRONGS who are still owed almost £12,500,000 on the 56 Capital Airlines' Viscounts.

The shareholders' association want Vickers to hold its hand long enough for them to elect new directors. They claim that the airline has loyal and intelligent employees and that they have a workable plan for increasing the amount of use the public makes of the airline's services.

What the employees are afraid of is that if their last minute action is unsuccessful a trustee order under the United States Chandler Act would follow. This they believe could lead to a form of reorganisation that would eliminate stockholders' rights and possibly put the 8,000 employees out of work.

Birmingham Engineering Centre at Poznan

The ENGINEERING CENTRE, the permanent engineering exhibition at Birmingham, is taking part in the Poznan International Trade Fair and is handling all engineering enquiries at the Government stand in the British pavilion.

The centre points out that company literature printed in Polish will obtain the greatest return, although German is also widely spoken and a number of people are familiar with English.

The British pavilion at Poznan has representative support from home companies and there are hopes that it may help to reverse the recent falling off in Anglo-Polish trade.

Nuffield at Valencia Samples Fair

Odd indeed are the importing arrangements into Spain. The importer who would like to sell his cars in Spain does not simply apply for an import licence and then worry about the service set-up.

The would-be car importer into Spain must submit a full list of his vehicles and a Government department will then decide which models, and how many, shall be allowed in.

The NUFFIELD ORGANISATION, having overcome these pecularities, have some 3,000 cars registered in Spain and take advantage of the violent nature of the terrain to do quite a mileage of motor testing on the roads there.

At the Valencia Fair this month TREMOR-OSNUR, the Nuffield distributor in Madrid, is showing three Nuffield vehicles. They are the Morris Oxford, which has a following in Spain, the 4-door Morris Minor and a J2 Morris Minibus.

At the Barcelona Fair, next month, FIOL ROCA, the local Nuffield distributor, will be showing a number of Morris cars and a Nuffield Universal DM4 tractor.

The 20 Year Rise in Unit Labour Costs

Perry T. Egbert, chairman of the United States ALCO PRODUCTS Company, has declared that the predicted improvement in the demand for capital goods in North America "has not yet begun to materialise."

Many sectors of the economy had recovered from the steel strike and the 1958 recession but it looked as if the upswing in demand for capital goods was not going to begin until later this year.

Going into detail on a number of "problem areas," Mr. Egbert said that management was faced with a never ending demand from labour for a growing share of the dollar profit. Unit labour costs had been rising steadily for 20 years and in fact keeping ahead of increasing productivity.

Of foreign competition, the ALCO chairman repeated the well known opinion that American industry was pricing itself out of foreign markets. Its home market was becoming a target for the overseas manufacturers.

The Optimum Size for Ocean Liners

Launching of two more liners last week once again poses the question: how big should a liner be? The Chandos Committee, in preparing their report on replacement of the "Queens," have given much thought to this problem.

BY COINCIDENCE two new transatlantic liners were launched last week, almost on the same day. The Empress of Canada was launched at Walker-on-Tyne, near Newcastle, on 10 May, by Mrs. John Diefenbaker, wife of the Canadian Prime Minister, and the France was launched on the following day at St. Nazaire by Mme de Gaulle, wife of the French President.

The 27,300 ton Empress of Canada is being built by Vickers-Armstrongs (Shipbuilders) Limited for the Canadian Pacific Line. She will be used mainly on the company's passenger and freight service between Great Britain and Canada, but will also be used for tropical cruises during the winter months. The 65,000 ton France is being built by the Chantiers de l'Atlantique (Penhoët-Loire) for the French Line, Compagnie Générale Transatlantique Limited. She is destined for the Le Havre to New York via Southampton passenger service, and will be capable of making the Atlantic crossing in five days. Both vessels will carry first and tourist class passengers and have certain features in common, although they differ notably in one important respect, that of size.

The accompanying table compares the principal features of these two new vessels, and the Cunard Line's Queen Elizabeth has also been included so that direct comparison can be made with a transatlantic liner of prewar design. Some apparent anomalies are evident, for instance, though the France and the Queen Elizabeth are very similar in size, the former's tonnage and draught are much less, making possible a higher service speed but with an identical shaft horsepower rating. A considerable saving in weight has been achieved in the France, both by the extensive use of aluminium in the super structure, and also by the virtual elimination of hull rivets in favour of welding. This latter feature also helps to minimise the tractive resistance.

Comparative Sizes of Empress of Canada, France and Queen Elizabeth

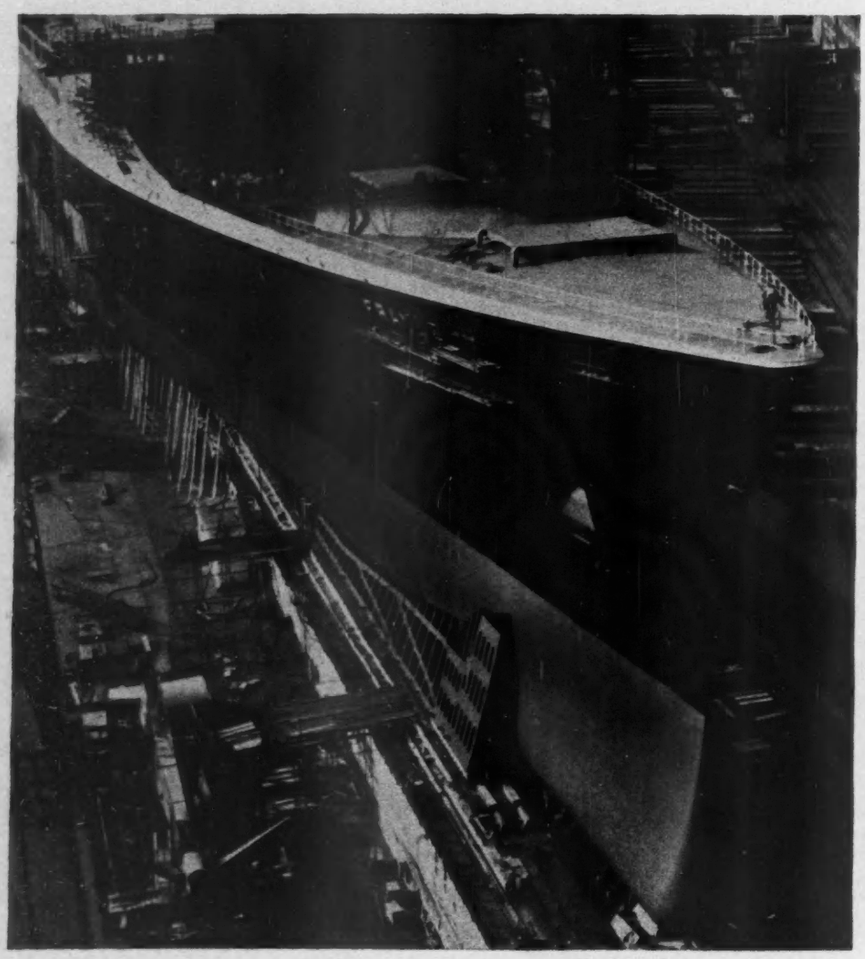
	Empress of Canada	France	Queen Elizabeth
Year entering service	1961	1962	1940
Approximate net tonnage	14,200	55,000	41,700
Approximate gross tonnage	27,300	65,000	83,700
Length overall	650 ft	1,035 ft	1,031 ft
Breadth	86 ft	110 ft	118 ft
Draught	29 ft	34 ft 6 in	39 ft
Shaft horsepower	27,000	160,000	160,000
Service speed	21 knots	31 knots	28½ knots
Engines	D.r. geared turbines	S.r. geared turbines	S.r. geared turbines
Passengers:			
First class	300	500	820
Tourist class	1,150	1,500	1,470
Total	1,450	2,000	2,290

If the number of tons gross per passenger is taken as a measure of the luxurious roominess on board, then the France and the Queen Elizabeth are almost equal on this score. This may appear surprising in view of the present-day trend towards economy of space, and in particular because the Queen Elizabeth is a three-class ship, an arrangement which is itself wasteful of space. It must be realised, however, that the France, apart from being a revenue-earning ocean carrier, will also be a prestige ship similar to our own Queens. As a result her construction is being aided to the extent of about 20 per cent of the £27,000,000 she is costing to build, by the French Government.

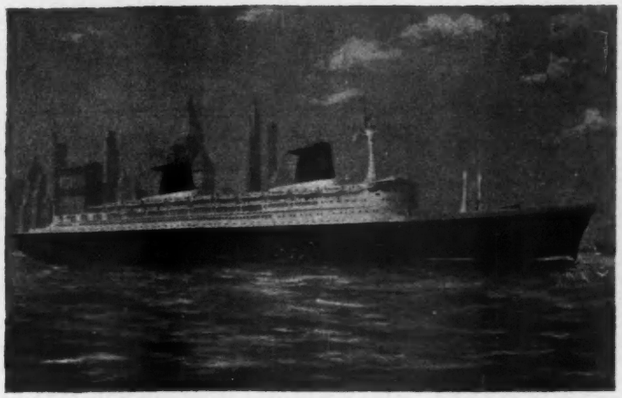
In the Empress of Canada on the other hand, full advantage has been taken of the current trends, by designing her as a dual-purpose ship. While she is intended primarily for the North Atlantic run, she will also be suitable for tropical cruises in the winter months when the Atlantic trade is at its slackest, and for which a larger vessel would be impracticable and uneconomical. Minor changes in her internal layout are all that will be required to convert her from the transatlantic run to cruising service, or *vice versa*. No doubt this factor has also been taken into account in designing her propelling machinery, since high speed is not required for cruising. Here then is a strong pointer towards the trend in liner designs of the future.

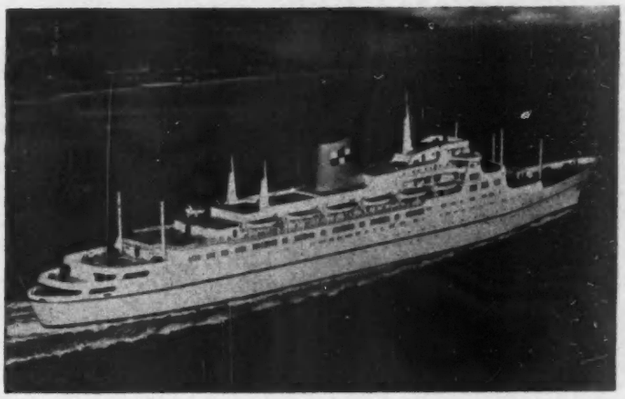
One of the accusations sometimes levelled at our own Queens is that they only carry their full complement of passengers during the summer months, and that during the winter they do not carry a sufficiently full payload. If each Queen were replaced by two smaller ships of the same combined passenger complement, it is argued, one could be laid up each winter and the idle time used to effect overhauls and repairs.

Rather surprisingly, therefore, when the French Line were faced with the choice of a new vessel or vessels for transatlantic service, they decided on one giant liner, the France, instead of two smaller ones of about 35,000 tons each. It was estimated that although the cost of building one large liner was much the same as for two of medium size, the receipts earned by the one would be about one third more than the total produced by the other two. The France will be able to make 23 double trips to New York and



The France on the slipway at St. Nazaire, being prepared for launching. The two specially-designed funnels will not be fitted until the last few months before entering service early in 1962.





Artist's impressions of the new liners in service, 65,000 ton France (left), 27,300 ton Empress of Canada (right).

back each year, carrying 92,000 passengers in that time. This figure exceeds the combined total offered by the Ile de France and Liberté which are at present operating this service.

The ill-fated Normandie, which put up such spectacular performances on the transatlantic route in the immediate pre-war years, was almost identical, in size to the France, but with engines developing the same horsepower the Normandie was two knots slower and consumed 40 per cent more fuel, which shows the advance made in the design of steam turbine-driven machinery for ships during the intervening 22 years.

Despite the considerable difference in size between the two new liners, the France and Empress of Canada, they have several significant design features in common. The extensive use of welding in place of rivetting in hull construction contributes to both lightness and speed, although in the Empress of Canada rivets are used between the frame members and the shell. The bulbous lower portion of the bow is another common feature, this is intended to reduce pitching in a heavy sea and will be an important contribution to passenger comfort. Stabilisers are of course also fitting as standard liner equipment, but the France has two pairs designed to reduce rolling to a maximum of 2° either side of the vertical.

Like the Queen Elizabeth, both the France and Empress of Canada are driven by geared steam turbines, only using higher steam conditions. The France has eight boilers providing steam at a pressure of 65 kilos (928 lb per sq. in) and a superheated temperature of 896° F. Consideration has been given to the possible eventual substitution of a nuclear reactor in place of the boilers.

The Empress of Canada has three Foster Wheeler boilers, two controlled superheat and one reheat type, supplying steam at a pressure of 650 lb per sq. in and temperature of 850° F at the superheater outlet. The two sets of double reduction geared turbines are of Pametrada design working on a reheat cycle.

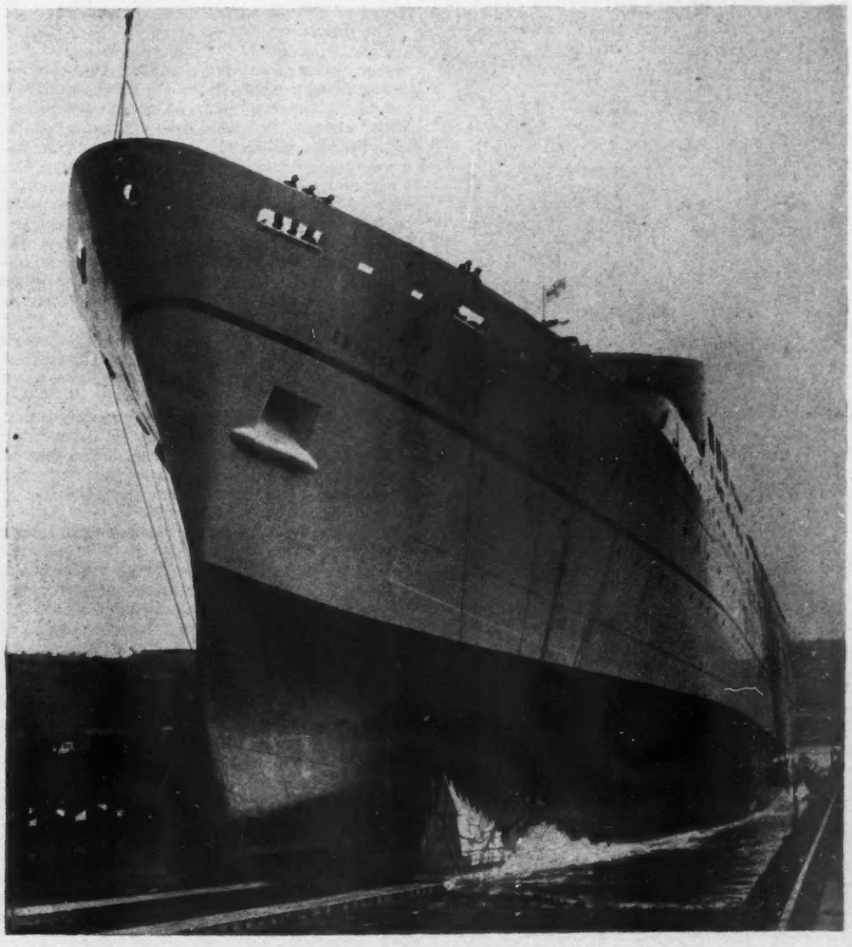
The standard of accommodation in both the new liners will be of a very high order indeed. Both differ from the Queen Elizabeth in that only two passenger classes exist instead of three, in accordance with present-day practice. In the Empress of Canada full advantage of this has been taken to facilitate changeover between transatlantic and cruise duties. When cruising the two classes will be combined into one, and the total passenger complement will be reduced from 1,450 to 750. The Empress of Canada also possesses adequate cargo space in accordance with the freight traffic requirements of her normal duties on the North Atlantic run.

One of the principal effects on her design imposed by her dual role is the provision of generous open deck space for the use of passengers when cruising in tropical waters.

The France is being fitted out in a manner worthy of her name. In addition to the fitting of stabilisers and a bulbous bow, her length will contribute to her stability at sea since she will always ride over the crests of three waves. In building her upperworks very extensive use has been made of aluminium, this not only assists materially in keeping down her weight, but also increases her stability. Internally the ship has been designed so as to divide the layout of first and tourist class accommodation on a horizontal basis instead of the more usual practice of separating them vertically. By this means passengers of either class will gain the impression of being on board a one-class ship.

The Empress of Canada, destined to be the flagship of the Canadian Pacific fleet, is due to make her maiden voyage to Montreal in April next year.

The France, which will be the longest ship in the world and the newest luxury liner, is due to make her maiden voyage to Southampton and New York early in 1962. The question remains, will she be the last really large transatlantic liner to be built?



The Empress of Canada moving down the slipway during her launching by Mrs. Diefenbaker at Walker-on-Tyne on 10 May. The welded and rivetted construction of the hull is visible.

Compression Ratio Varied While Running

The performance of a petrol engine could be optimised by suitably varying the compression ratio during operation. A practical method of doing this has been developed by the British Internal Combustion Engine Research Association.

THE compression and expansion ratios of a piston engine are usually equal and are given by the full volume of the cylinder divided by the volume to which the contents are compressed at the end of the compression stroke. The compression ratio has normally a fixed value in any given engine whether petrol or diesel and in the design of an engine is one of the most important choices to be made as it conditions the charge for combustion and its equal and opposite ratio largely determines the efficiency of the engine.

In the petrol engine the ratio is made as high as is possible without causing detonation when the throttle is open. It should be noted that at part throttle openings much higher compression ratios could be used in the petrol engine with a

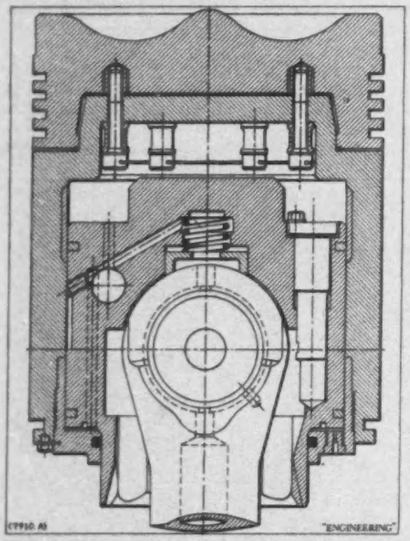


Fig. 1 Cross-section of new piston developed by Bicera.

corresponding improvement in efficiency. The real requirement of the petrol engine is thus for a variable compression ratio, and it is only for want of a satisfactory and cheap means of varying the ratio that a fixed ratio is used.

In the naturally aspirated (i.e. unsupercharged) diesel engine, the fixed ratio chosen is usually a compromise between a high value which gives the best cold starting and the somewhat lower value which gives the most satisfactory conditions for long engine life at high load and low first cost. In the pressure-charged (i.e. supercharged) engine, a lower value of compression ratio is chosen with some loss of cold-starting ability and part load performance, in order that the maximum cylinder pressure reached at high outputs shall not impose excessive loads on the structure and moving components of the engine. Unlike the petrol engine in which detonation severely limits the possibility of pressure-charging, the diesel engine has a remarkable basic ability to consume increased quantities of fuel and air and develop correspondingly greater power, but because of certain secondary problems this is not easily accomplished. If these secondary problems are overcome three times the power of the naturally aspirated engine can be produced. As engines are developed towards high-power conditions, the use of a compromise compression ratio becomes increasingly unsatisfactory.

Even when the ratio is reduced to the bare minimum necessary to obtain cold starting and satisfactory running at light loads, the cylinder pressures reach such high values at the maximum load, that the engine structure and running components must be made extremely strong. In spite of the resultant added weight and cost the factors of safety at which the bearing surfaces in such an engine operate, must be less than if these very high pressures could be avoided.

The Bicera variable-ratio piston was developed as an aid to high pressure turbocharging and a characteristic of turbocharging is that the charge increases with increasing load. This is advantageous in that the air supply tends to keep pace with the demand but together with an increase in fuel it results in a rapid rise in maximum cylinder pressure as the load is raised. If the compression ratio is to be fixed, it must be fixed at a value high enough for reliable starting, smooth idling and reasonably economical low-load running, and this ultimately limits the charge pressure that can be safely used for full load, and therefore the full load itself.

By automatically adjusting the compression ratio in accordance with the load, the Bicera variable-ratio piston greatly extends the load range of an engine of given strength without sacrificing good starting, idling, and low load running. This piston is therefore a contribution towards solving the problem of high mechnical loading in highly pressure charged engines. The piston's function is to automatically limit the maximum cylinder pressure to any value which may be selected as a basis of engine design having regard to all influencing factors.

The piston, of which a cross-section is shown in Fig. 1, consists of two main components, the piston (outer member) and the gudgeon-pin carrier (inner member) with limited relative movement between them. This relative movement, whereby the value of compression ratio is adjusted, is produced by the action of the maximum pressure of the gases upon the lubricating oil in an upper oil chamber, and an annular lower oil chamber. The movements of oil are effected in the following manner. Oil from the passage in the connecting rod is fed under pressure to two non-return valves mounted on a bore and then via flow passages to the upper or lower chamber, as one or the other increases in volume.

This arrangement ensures that both chambers are at *all* times full of oil. The upper chamber is provided with one or more spring loaded relief valves through which oil is discharged to the engine sump, when the pressure in the upper chamber, due to the pressure of the combustion gases momentarily exceeds a selected pressure. A certain leakage of oil from the lower chamber is permitted via a fixed discharge orifice.

The action of the Bicera variable-ratio piston is as follows:—

During the latter part of each exhaust stroke and the first part of each induction stroke, the inertia force of the outer member makes it overshoot slightly so compressing the oil in the lower chamber and forcing some oil out of the discharge orifice. A small upward relative movement of the outer part therefore occurs, which of course is dependent on the size of the orifice chosen and in the case of a 8·5 in diameter piston amounts to 0·06 in. When the load on an engine fitted with such a piston is reduced, so that the maximum cylinder pressure has temporarily fallen below the selected value at which it is required to be held constant, the small upward movement occurs on each cycle raising the compression ratio until the maximum cylinder pressure reaches a value which is just sufficient to cause the spring loaded discharge valve serving the upper oil chambers to open and discharge oil, so that a small downward relative movement of the outer part occurs.

Thereafter, until a further change of load occurs, equal upward and downward movements of 0·004 in occur, so that the piston remains at a substantially fixed setting, giving the desired maximum cylinder pressure. If the load is next increased so that the maximum cylinder pressure tends to rise above the selected value, the discharge of oil from the upper oil chamber will suddenly increase so that there will be a rapid downward movement resulting in a lower ratio setting which maintains the desired limiting value of maximum cylinder pressure. In the lower load range where the maximum cylinder pressure is less than the limiting value selected, the piston remains in its maximum ratio position.

The performance comparison in Fig. 2 shows how the piston changes the compression ratio as engine load changes, and its consequent pressure and specific fuel consumption. The broken lines show the corresponding conditions in an engine having a fixed compression ratio. The fixed ratio must be a compromise between the conflicting requirements of starting and light load running on the one hand, and running at maximum load on the other.

This usually means using the lowest ratio at which satisfactory starting can be achieved at low temperatures, but even then for a given output

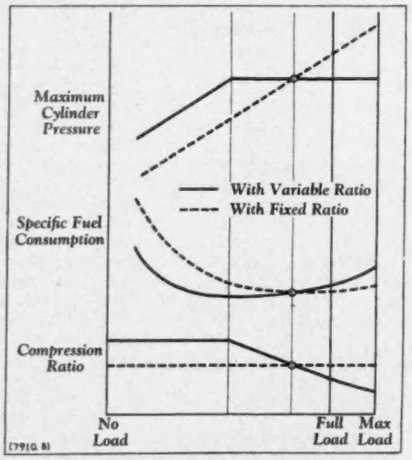


Fig. 2 Performance comparison, showing how the Bicera piston changes the compression ratio as the engine load changes.

the fixed ratio engine must be designed to withstand much higher pressures at maximum load than the variable ratio engine. As the fuel consumption curves indicate, the loss of efficiency due to the use of lower ratios at the higher loads would be offset by the improved efficiency due to the provision of higher ratios at part loads.

The piston itself is more reliable than a conventional piston operating at high outputs, not only because it carries smaller gas pressures, but because the outer portion which bears against the cylinder walls is a plain cylindrical part, free of the distortion which the gudgeon pin bosses of a normal piston produce, and because the gudgeon pin and its associated bearings are arranged in a part which is free of thermal distortion being insulated by the oil in the upper chamber, it operates at a relatively low temperature.

Pistons of the design shown in Fig. 1 have been used in a pressure-charged three cylinder engine with 8·5 in bore of long-established design. They enabled an output three times that of the engine in its original aspirated condition to be obtained without over-stressing. The performance of a petrol engine could be optimised by suitably varying the compression ration during operation.

Vibrations on VTOL Aircraft

As aircraft design requirements become more stringent, it is desirable to ensure that no excessive vibration occurs which would cause structural deterioration and effect the performance of electronic equipment. The SC1 VTOL (vertical take-off and landing) aircraft, having four powerful jet engines mounted in the fuselage centre, is an obvious example of an aircraft requiring some sort of vibration analysis.

To measure and record the vibration levels throughout the SC1, Midas magnetic data

A measuring instrument data analysis system (Midas) being installed on the SC1 vertical take-off aircraft.

recording equipment, manufactured by Royston Instruments Limited, Byfleet, Surrey, has been installed. The equipment consists of a power unit mounted in the forward lower equipment bay and a recorder and selection switch mounted in the aft lower equipment bay. There are approximately 30 vibration pick-up points on the aircraft, six points being recorded simultaneously. There is also a speech channel enabling the test conditions to be recorded at the same time. A six-way switch is incorporated to give five ten-second runs and a ten second blank per minute.

The information is recorded on tapes which can be analysed on Midas play-back equipment either at the Royal Aircraft Establishment or at Royston Instruments Limited. The analysis will give a frequency/amplitude plot up to 500 cycles per second. Should any excessive vibration be noticed, it can be closely investigated and the cause remedied. The equipment has been installed in the aircraft at Bedford, and vibration testing during transition flights is now being undertaken.

Hot Cracking in Steels

High strength steels play an important part in the performance of modern aircraft and missiles. The development of welding methods that will provide joints with strengths equal to those of the alloys themselves is of prime importance if these steels are to do the job required of them.

A report issued by the Battelle Memorial Institute, Ohio, USA, states that the use of ultra-high strength steels has been hampered by several welding problems, the most serious of which is hot cracking. Hot cracking occurs as the weld deposit cools, at a point just below the solidification temperature. In a recent study, workers at Battelle investigated hot cracking of SAE (Society of Automotive Engineers) 4,340 weld metals. They studied the hot cracking tendencies of the steels with a freezing-cycle hot-tension machine which duplicates the welding thermal cycle. The research showed that a combination of high sulphur and phosphorus contents, though within the specification limits for the steels, greatly reduced their freezing-cycle hot tensile strength and ductility.

The correlation of a large number of results showed that sulphur and phosphorus cause appreciable hot cracking if either exceeds about 0·017 per cent in weight. This holds true even when the other element is present in amounts below 0·010 per cent. A combined total of the two elements exceeding 0·020 and 0·025 per cent in weight creates serious difficulties. Thus a limit of about 0·010 per cent of each element is desirable.

Radar Fire Control

An announcement that they are actively engaged in the development of another radar fire control system has been made recently by Ferranti Limited. To be known as Airpass II, the new system will have many features of Airpass I, which was successfully demonstrated at Farnborough last September.

Airpass II is to be suitable for use in single seat, or two seat aircraft and is being designed by Ferranti as a private venture to meet the requirements of many foreign governments for a dual-purpose fire control system. Its principle objective is to meet attacks made with conventional weapons, and it will provide the following facilities: (1) air-to-air radar search and automatic target tracking; (2) computer controlled approach for blind or visual attacks with a variety of air-to-air weapons; (3) radar assisted attacks against surface targets with a variety of weapons.

In addition, because the approach to surface targets must often be made at low level, the radar can be used as a navigation and low flying aid.

Investigating the Eye's Memory Capacity

Recent experiments have shown that the human eye can retain a surprising amount of information for a short time; much more than would be inferred from asking a person to "read back" information that he has just seen in a brief flash. Furthermore, information stored in this temporary memory can either be allowed to fade gradually or it can be erased selectively by succeeding stimuli. Erasure takes place before the viewer is actually aware of what he has seen, according to a technical paper recently read before the American Optical Society, by Dr. E. Averbach and Mr. A. Coriell, both of whom work at the Bell Telephone Laboratories in New York.

In their experiments, the investigators flashed an array of letters on a screen, followed a short time later by a marker which pointed to one of the positions previously occupied by a letter. Initially, two horizontal rows of eight letters each were flashed for one twentieth of a second. The screen then remained blank for a variable period, up to one half-second, after which a solid vertical bar appeared for another twentieth of a second above or beneath one of the letter positions. When the bar followed the letters immediately the viewer was able to identify the letter correctly in 60 to 70 per cent of the trials. This ability decreased gradually with increasing time lag to about 20 to 25 per cent when the marker was presented one quarter of a second later.

In the second set of experiments, 16 letters were again exposed to the viewing subject for a twentieth of a second. After this exposure, and a variable-length blank interlude, a circular marker was flashed at one of the letter locations. This circle was large enough so that if it were exposed simultaneously with the letter, the letter would be completely inside it. In contrast to the experiments where bar markers were used, the ability of the subject to identify the marked letter dropped abruptly in one tenth of a second to about 10 to 20 per cent. The circle apparently erased the letter from the viewers visual memory. It is particularly interesting to note that the erasure occurred even when the letters were exposed in one eye and the subsequent circle in another.

Dr. Averbach and Mr. Coriell are of the opinion that these experiments indicate the presence of a short-term visual memory which is capable of very fast "read-in," but which "reads-out" information to the more permanent memory relatively slowly. This storage apparently includes a mechanism by which new information tends to erase the old. The temporary storage time is of the order of a quarter of a second, and the minimum storage capacity determined experimentally has so far ranged between 35 and 54 bits, depending on the subject tested.

While the results reported represent very early experimental work, the Bell Laboratories visual research scientists hope that additional investigations along these lines will shed light on how the nervous system stores and scans information, as well as on the manner in which such information is transferred and processed.

The Temperature of Outer Space

News of further research into the conditions prevailing in outer space has recently come from the Observatory of the University of Bonn, Western Germany, where they are soon to begin an intensive investigation into the temperature conditions of interstellar gas.

To this end special low-noise amplifying equipment, employing travelling-wave tubes, has been manufactured for the University by Marconi's Wireless Telegraph Company Limited, Chelmsford. This equipment consists of a dual channel amplifying system incorporating two travelling-wave tubes in cascade in each channel.

The radio telescope, a parabolic mirror of 83 ft diameter mounted on a pyramidal tower about 60 ft high, scans the sky picking up the

Equipment has been specially manufactured in Great Britain for the Observatory at Bonn University, where inter-stellar gas temperatures are being studied by means of radio astronomy.

cosmic continuum of radiation emanating from galactic and extra galactic radio sources. The signals in the neighbourhood of the hydrogen line frequency (1,420 Mc/s) are amplified by one pair of travelling-wave tubes, the other pair of tubes being used to amplify reference noise signals from a known resistor at a known temperature.

The outputs from the two amplifying channels are detected, integrated and compared and the effective cosmic temperature determined; from these data, contour maps are prepared. So accurate has the system been in initial tests that a discrimination of 0·1° K has been achieved. The research programme at Bonn University is being carried out under the direction of Professor Becker, assisted by Herr Heinz G. Muller (seen in the illustration). The travelling-wave tubes were manufactured by the English Electric Valve Company, who are also at Chelmsford, Essex.

Impulse Testing with a Storage Tube

The functions of the normal oscilloscope have been considerably increased in recent times by the development of a display-storage cathode ray tube. A typical application is the impulse testing of electrical equipment.

By E. L. White, B.Sc., (Eng.), A.M.I.E.E.
Electrical Research Association

With the advent of the display-storage cathode-ray tube[1 2 3 4] (d.s.t.), new techniques became available in the observation and measurement of transient phenomena. These have been successfully applied by the Electrical Research Association, Leatherhead, Surrey, in high-voltage impulse testing.

As its name implies, the d.s.t. can store and also display information supplied to it, either as a picture or as an oscillogram. The brightness and duration of the display are largely independent of the time involved in storing the information. For example, an oscillogram lasting only a few microseconds can be observed in normal room lighting for 30 seconds or more.

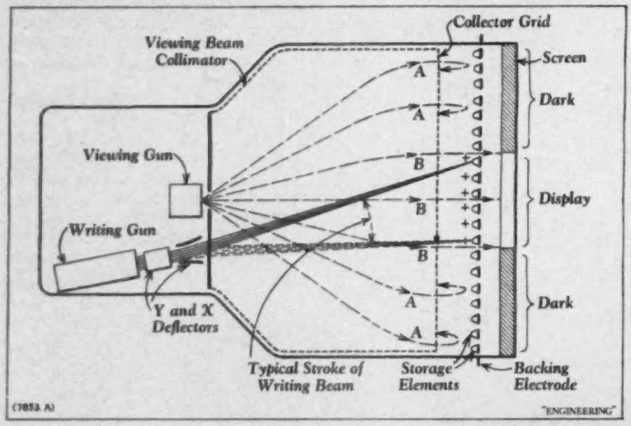
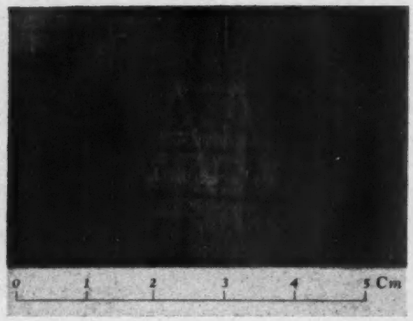


Fig. 1 (left) The viewing electrons at A are repelled by unwritten storage elements. At B they penetrate the backing electrode, where the writing beam has left positive charges on storage elements.

Fig. 2 (below) Single-sweep record of a 10 Mc/s oscillation, displayed and photographed in normal room lighting.



The conventional procedure in impulse testing is to trace oscillograms on a high-speed single-sweep oscillograph[5] (h.s.o.). As the eye cannot retain an image of a single trace for more than a fraction of a second, visual inspection of the oscillograph screen does not normally give sufficient information and it is necessary to photograph the trace. Although the loss of time between recording an oscillogram and inspecting the record can be minimised by using fast processing techniques, it is nevertheless undesirable.

The greatest advantage of the d.s.t. in impulse testing is that it can eliminate this loss of time, since an oscillogram can be displayed immediately it is recorded. While it is displayed it can also be photographed if necessary.

TUBE PRINCIPLES

In order to appreciate fully the results obtained, some understanding of the principles of the d.s.t. is required. Fig. 1 shows how an electron beam (writing beam) is produced and deflected in the normal manner of an electrostatic oscillograph beam. However, before reaching the fluorescent screen the writing beam impinges on a mosaic of dielectric storage elements supported on a fine metallic mesh (backing electrode) situated near to and parallel to the screen. The surfaces of these elements are initially charged to a uniform potential but those along the track swept by the writing beam become more positive than the rest by secondary emission. The secondary electrons land on the still-more-positive collector grid. Under suitable conditions the resulting pattern of charges stored on the dielectric surface can be retained for a long time.

Another electron beam (viewing beam), consisting of a steady parallel stream of low-velocity electrons, floods the whole area of the storage surface. Normally the potential of the storage surface is such that viewing-beam electrons do not land on the dielectric and are able to penetrate the holes in the backing electrode only in the immediate vicinity of the more positive storage elements. The remaining electrons are repelled and land on the collector grid. Those which penetrate the backing electrode are accelerated by a high positive potential applied to the screen, and on striking the screen produce a display which can be described as an electron silhouette of the potential distribution on the storage surface, made visible by fluorescence.

The stored information can be intentionally erased by momentarily causing viewing-beam electrons to land upon the whole storage surface and charge it to a uniform potential. Unintentional charging of the storage surface by positive ions, most of which are produced by collision of viewing-beam electrons with residual gas molecules, eventually results in erasure and thereby limits the duration of the viewing operation.

IMPULSE TESTING

In its application to impulse testing the principal limitations of the d.s.t., in its present state of development, are lack of definition and rather low writing speed. Bearing in mind other sources of error in measuring high-voltage impulses the slightly poorer definition of an oscillogram displayed on a d.s.t. compared with that of a photographic record from an h.s.o. has a negligible effect on the overall accuracy of most measurements. Where maximum resolution of fine detail is essential, as in supplementary records required for fault detection in impulse tests on transformers, the d.s.t. is not yet a substitute for the h.s.o. normally used but can usefully be operated as a monitor giving less detailed but immediate information while the tests are in progress.

For oscillography, a maximum writing speed based on a minimum acceptable contrast in brightness between the display and the background can be as much as 50 times greater than the nominal maximum which is defined in terms of a trace written from zero to maximum brightness. This applies only to d.s.t.'s designed to record and display half-tones. Even so, the highest writing speed which has given a useful display is at least an order of magnitude below that expected from a conventional high-speed sealed-off tube. However, it is more than is necessary for recording the wave front of a standard 1/50 microsecond impulse. The oscillogram of Fig. 2 shows the contrast obtained at a writing speed of 500 mm per microsecond.

This record, and the examples of high-voltage impulses shown in Figs. 3 and 4 were recorded with commercially-available d.s.t.'s incorporated in an instrument developed by the ERA. In Fig. 3 (*b*) the trace of the rapid downward sweep of voltage due to breakdown of the test specimen was clearly visible in the display and in the original photograph. This collapse of voltage was estimated to have a duration of the order of 0·1 microsecond. Owing partly to avoidable defects in the associated circuits, very-high-frequency disturbances originating from the impulse-generator spark gaps were

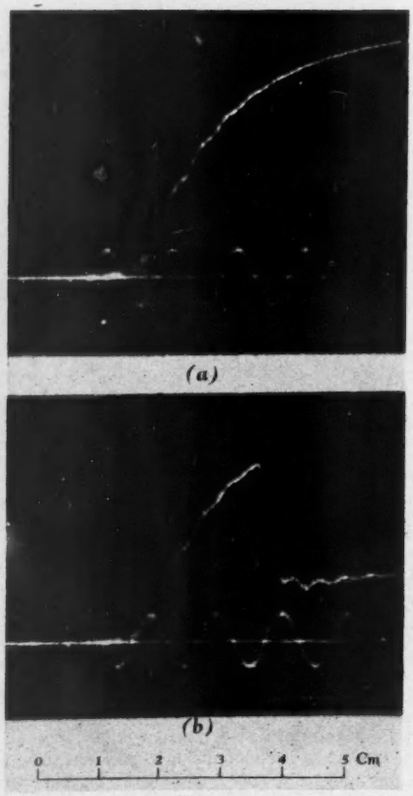


Fig. 3 High-voltage impulse records, using RCA tube type 6866. (a) Wave front of 250 kV impulse; timing oscillation 2·5 Mc/s. (b) Wave front of prospective 250 kV impulse, chopped by breakdown of a specimen of wood; timing oscillation 2·5 Mc/s.

superimposed on the sweep and beam-modulating voltages, resulting in the partial disappearance of the first part of the impulse wave front; a common fault in this branch of oscillography. A contributory cause of these disturbances is probably lack of screening within the d.s.t.'s which differ constructionally from the h.s.o. in not having short side-connections to the deflectors and final anode. The d.s.t.'s used could be described as general-purpose tubes and it is believed that a significant improvement in results could be achieved with a tube designed with special attention to its high-frequency performance and its writing speed. In principle, although the accelerating voltage of the writing system is limited by secondary-emission considerations to a rather low value, the beam current could be increased in order to raise the writing speed.

The examples shown demonstrate the ability of existing d.s.t.'s to give an immediate display, easily visible in normal room lighting, of most of the oscillograms normally recorded in an impulse-testing laboratory, with traces sufficiently fine for routine high-voltage impulse measurements. In this field of application, even small improvements in the high-speed performance of the d.s.t. could greatly increase its usefulness.

Two other facilities of the d.s.t., both relevant to surge problems, should be mentioned in conclusion. One is that successive impulses can be displayed simultaneously for comparison. The other is that the benefits of a repetitive display in making surge distribution tests with a recurrent-surge oscillograph[6] can mostly be achieved with the d.s.t. in a simpler way using single-stroke techniques.

The author wishes to thank the Director of the Electrical Research Association for permission to publish this paper.

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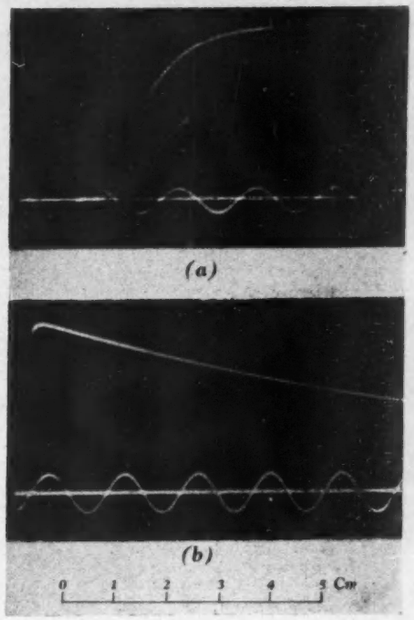


Fig. 4 High-voltage impulse records, using English Electric tube type E702A. (a) Wave front of 280 kV impulse. Timing oscillation 1 Mc/s. (b) Wave tail of 280 kV impulse. Timing oscillation 100 kc/s.

Compatible Colour Television Demonstrated

A unique demonstration was presented at the Institution of Electrical Engineers recently when two Frenchmen, MM. R. Chaste and P. Cassagne described a new system of colour television transmission. Scenes originating in Paris were seen in full colour by a large audience in London, on screens that differed little from those of ordinary monochromatic television receivers.

The new system is said to be compatible; that is to say that a single transmission will serve both colour and monochromatic receivers without impairing the presentation of either. This is an important feature since it would provide a means of introducing colour television to the nation on a gradual basis; meaning that viewers could continue with their old sets without disturbance until, if ever, they wished to buy a colour receiver (which would be very much more expensive than an ordinary television receiver).

The demonstration itself was described in an IEE statement to have been a triumph of engineering cooperation. Engineers of the French companies responsible for the development of the system, the French Posts and Telegraphs, the Radio Television Francaise, the GPO and the BBC all cooperated to set up a complicated radio link comprising sections of the existing Eurovision network, with additional microwave links of the type used by the BBC for outside broadcasts.

As a precaution against the all-too-likely failure of one of the sections of this complicated radio link, a video recording was made beforehand and brought to London so that the demonstration could be conducted without any prolonged delays. However, it speaks highly of the engineering cooperation between the various organisations and the two countries that the recording was not used at all.

Stereophonic Sound for Television

There is reason to believe that stereophonic sound, properly presented to loudspeakers disposed symmetrically to the left and right of the screen, could considerably enhance the interest and realism of a television programme. This was pointed out by Mr. D. E. L. Shorter and Dr. G. J. Phillips in a monograph entitled "A Summary of the Present Position of Stereophonic Broadcasting," published by the British Broadcasting Corporation, London, at 5*s*.

The authors go on to point out that a difficult situation may arise if the observer were thereby presented with directional information which conflicted with that provided by the picture and that, in the absence of any strong influence to the contrary, the eye is likely to take precedence over the ear in determining the point from which a sound appears to emanate. Therefore, the more effective the stereophonic system the more important it would be to avoid at least the grosser incongruities between sound and vision.

With the usual spacing of 5 to 10 ft between the left and right hand loudspeakers, the sound stage would be too wide for the size of picture provided by most domestic receivers. This disparity could be corrected by reducing the distance between the two loudspeakers, or by the roughly equivalent electrical device of introducing some degree of cross mixing between the left and right hand channels; but much of the spacious effect that is an attractive feature of stereophony would then be lost. It might be possible, however, by a suitable combination of microphones (with the addition, if necessary, of artificial reverberation) to transmit the direct sound on a relatively narrow front while allowing the reverberant sound to extend over the maximum width.

In all but the simplest forms of presentation, the stereophonic reproduction accompanying a picture might well have to follow such cinematic practices as panning across a scene and frequent switching from one viewpoint to another. In this case the resulting programme would be unacceptable for a sound broadcast; the sharing of a stereophonic programme signal with the sound service might therefore prevent full exploitation of the combined media.

In concluding their report on stereophonic broadcasting in general, the authors state that the addition of a stereophonic service to an existing broadcasting system is clearly feasible as an engineering proposition, but poses a number of serious economic problems. To provide a compatible stereophonic reception would probably require signal processing or coding equipment at studio centres or transmitters. Most of the compatible systems proposed would inevitably necessitate an increase in the number or in the power of transmitters; or a reduction in the service area; or a reduction of the standards of reception. Other systems so far proposed involve some deterioration in the stereophonic effect instead. In addition, a radical change in the present system of programme distribution by line would be required.

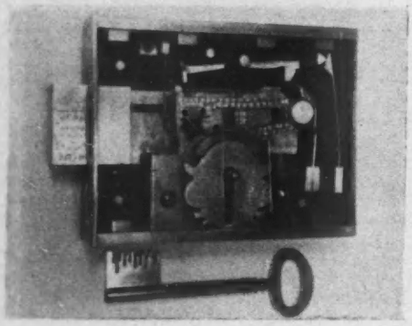
Whatever measures are to be adopted they must depend on the degree of public demand for the benefits of stereophony and the proportion of listeners who are prepared to equip themselves with the necessary receiving apparatus. For a realistic approach to the situation, it is necessary to consider what proportion of broadcast programmes would derive substantial benefit from stereophonic presentation, and to this end it will be necessary to gain experience with all types of programme. For cases in which stereophonic presentation is considered impracticable or pointless, it will be necessary to decide upon the best method of transmission. Some time must elapse before the picture becomes clear, but if a demand for a stereophonic service develops it is likely to have an appreciable influence on the futue of sound broadcasting.

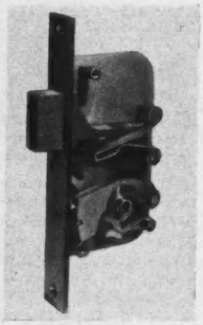
Lock and Key

SINCE the beginning of houses there have been means of locking doors. From the simplest form of the bar dropped across into a catch or thrust through two staples, down to the most modern lever or barrel lock with burglar alarm attached, the object has been the protection of property. As each form of lock was produced a new method was devised to pick it, so the repeated claims of the inventors went by the board one by one.

According to the *Encyclopedia Britannica* the earliest actual lock of which the construction is known is an Egyptian one about 4,000 years old. It is curiously similar to the modern Yale lock in that, while it has a sliding bolt, the bolt is held in position by dropping pins lifted clear by the key, which however went in the long way of the bolt. But for very many years the more usual form has been the lever lock of which an example is shown in the larger illustration.

This particular lock was made by Chubbs for the Great Exhibition of 1851 and was intended to incorporate all the security devices available at that time. It measures 12 in by 9 in by 3 in and weighs 42 lb (including the key). There are 17 levers each of which must be lifted the correct height to free the bolt and each of which is "false notched" so that if lifted too high or not high enough it will catch on a stop and prevent the bolt from moving more than a little way. Each lever is also very closely "gated" to fine limits so that the key is an accurate fit and a small difference in size would preclude its use.





On the left is the lock built for the Great Exhibition of 1851. It has 17 levers and 3 detectors and weighs 42 lb. The one on the right is a new design, using detainers instead of levers.

Then there are also 3 detector mechanisms. If when the bolt is thrown (that is, in the locked position) any attempt is made to pick it, or if a false key is used to try to open it, one of these mechanisms is brought into play, the safety lever latching home on the bolt and preventing any further attempt at moving it. With the detector in action even the true key cannot be turned to open the lock until it has first been turned to close the bolt and thereby freed the detector, so that the owner knows that some attempt has been made to pick it open.

Further protection is provided by the barrel and curtain which covers the keyhole after the key has been inserted and turning begun. This is another antipicking device for it allows only one pick to be inserted at a time.

Such a lock can only be operated from one side: to work it from both sides a symmetrical key would be needed, each half a mirror image of the other. With 17 levers this would make an almost impossibly large key—the present one as it is is some 8 in long. But obviously the greater the number of levers the greater the number of combinations possible and the less chance of opening by a false key. So for ordinary occasions a compromise has to be accepted.

Now after a very long innings of some 140 years, the Chubb lever lock is to be replaced by a new design—the Security range. The conventional levers that have been the basis of most door locks for so long have been replaced by a series of movable detainers. It is claimed that these provide a far higher degree of security by providing many more key combinations; they also make possible master key systems (as used in hotels and offices) which are far more secure. It is claimed that it is impossible to file a "junior" key to make it into one of "senior" rank.

In these new locks the bolt throwing device has been designed to reduce wear on the key and also to ensure that the bolt is always fully thrown when the key is turned. The key barrel is a tube into which the key is inserted when placed in the lock. It is one of the anti-picking devices described in the earlier type of lock and in this case it acts as a key guide as well to prolong the life of the lock. There is a monitor action that ensures that the bolt is fully secure when the key is withdrawn in the locked position and which prevents withdrawal of the key if the bolt does not go "home". This foils any packing of the socket.

The lock and the locking plate are of the mortice type and are designed to be stronger than the normal type of wooden door in which the locks are likely to be fitted. This means that the wood will fail before the lock itself. The locking plate has a steel box which encloses the bolt and makes it impossible to reach the head with a jemmy. In addition the bolt also includes one of the firm's patent safety devices in the form of two hardened steel rollers which extend the length of the bolt and are free to rotate. Thus if an attempt is made to saw through the bolt not only are the saw teeth damaged by the hardened steel but also the turning rollers offer no purchase for the teeth to cut at all.

Different combinations are obtained by changing the detainers, and the total number possible approaches the astonomical. No fixed wards are used and the keys are simple in form, made in bronze and precision cut with nine steppings. For the master key systems a special section steel is used for the keys so those from the standard range cannot be used. It is a claim of the firm that it is impossible to open any lock in the Security range with a skeleton key and also that it is impossible to alter any one key to open a series of locks. As the bolt on external door locks is fixed "dead", it cannot be sprung back and on the locking latch type for inside doors there is an automatic device to foil attacks by mica strip.

The locks are designed for easy production; cases are pressed steel and the bolt and follower are an iron sintered compact. The five detainers are hard rolled brass. The locking plate is pressed steel.

But even the best of locks require some attention and a device is now on the market for injecting a graphite lubricant. Called the Lok-Eeze, it is a small polythene container with a puffing action; a nice touch is that it takes the form of a policeman with the puff coming out of his helmet.

The Security range of locks is made by Chubb and Son's Lock and Safe Company Limited, 14-22 Tottenham Street, Tottenham Court Road, London, W1, and the Lok-Eeze by Ingersoll Locks Limited, 91 Moorgate, London, EC2.

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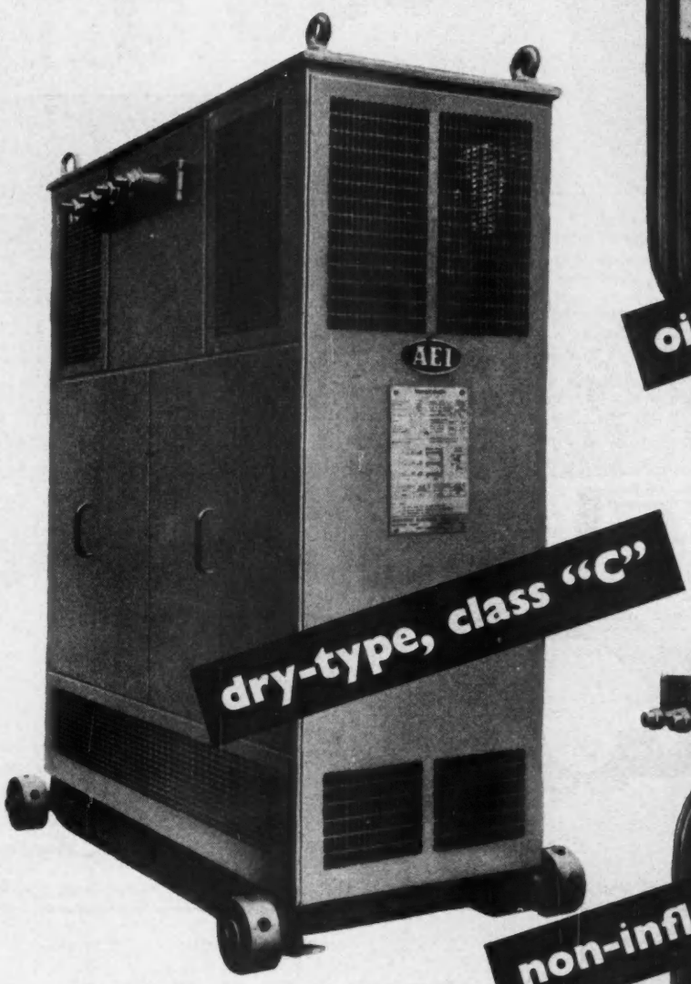

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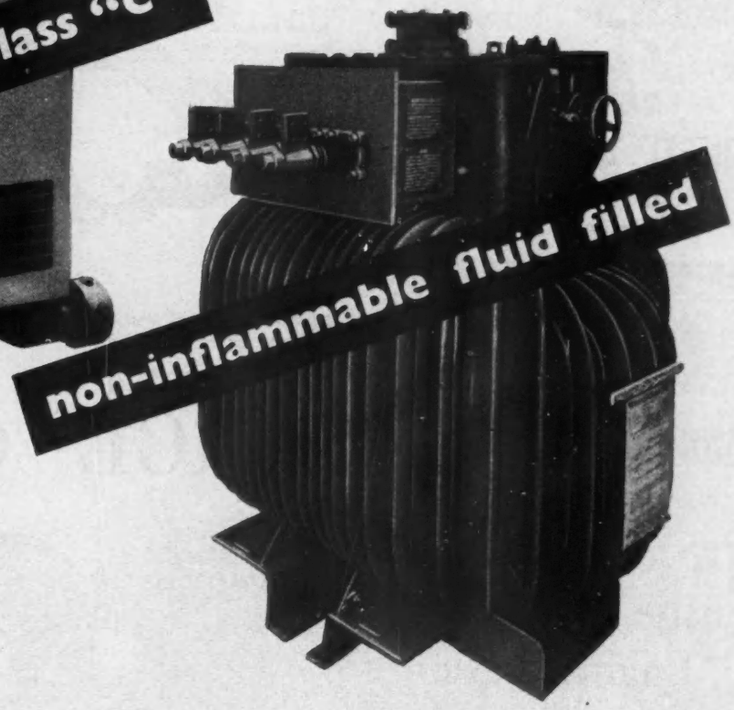

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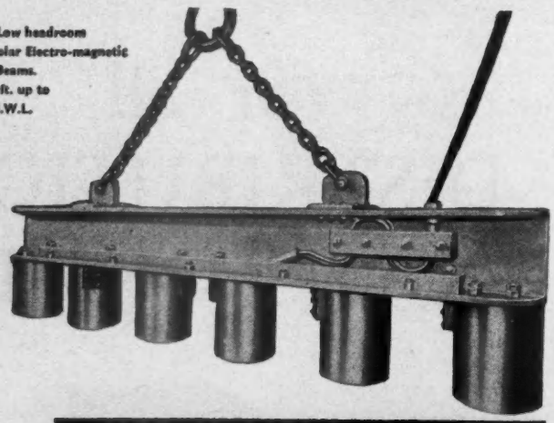

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Left: Crane driver operated lifting device for open top cases with 1" to 2" thick side walls.

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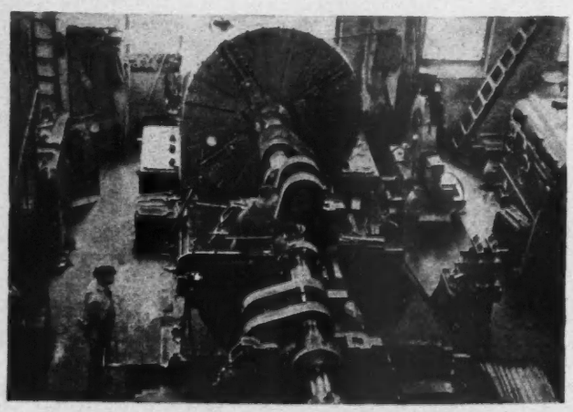

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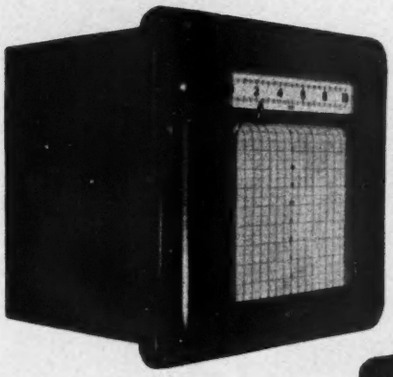

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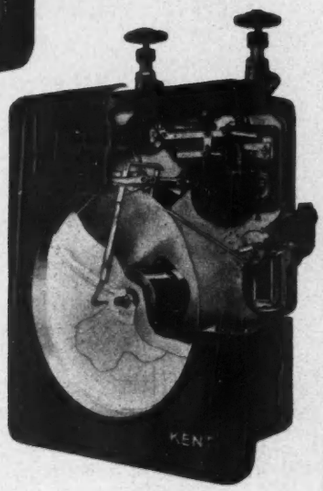

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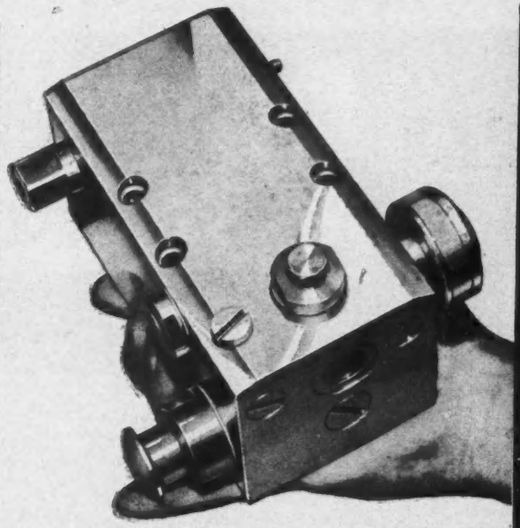

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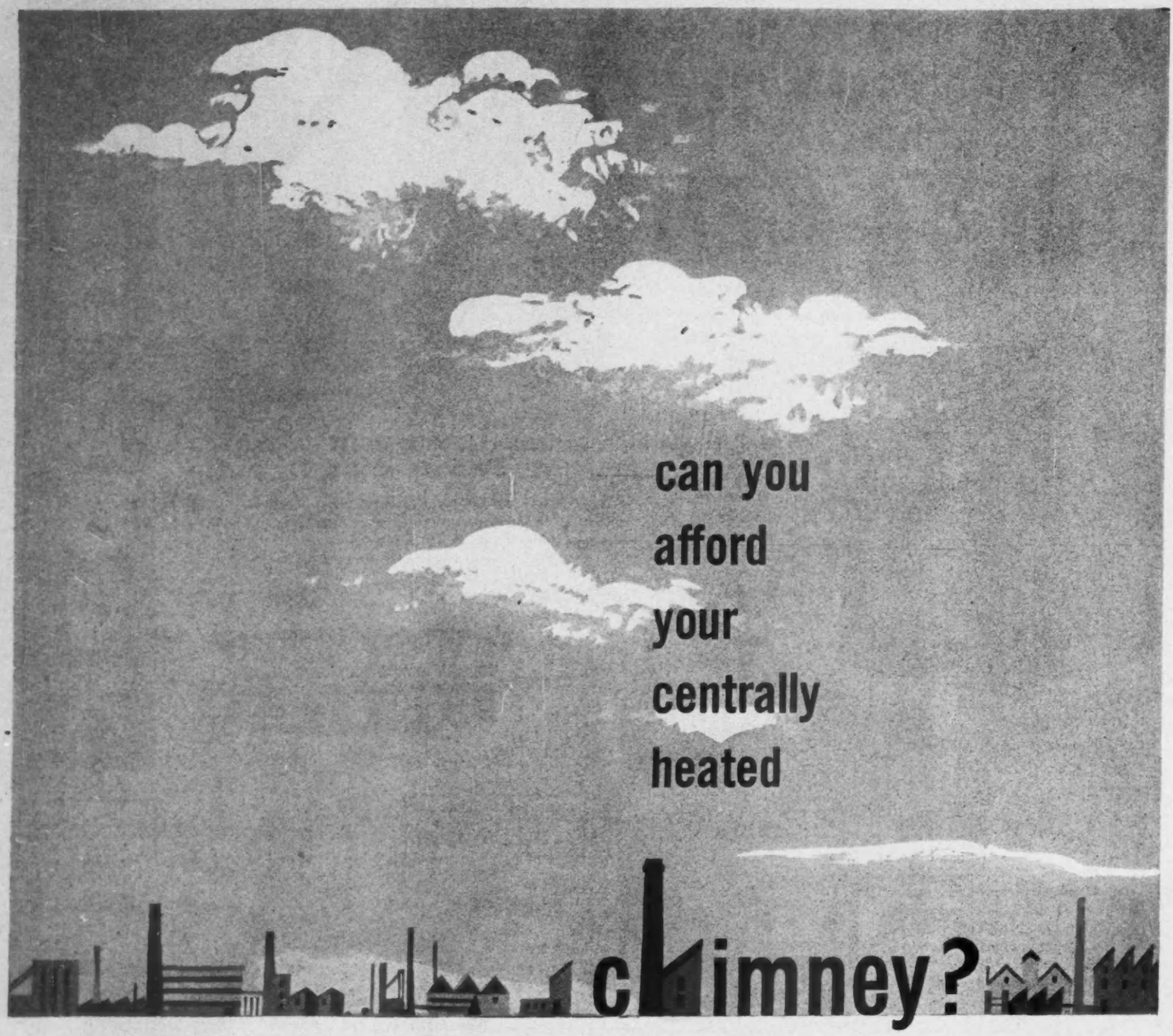

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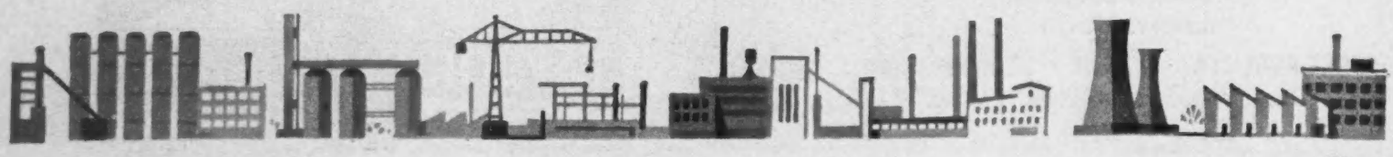

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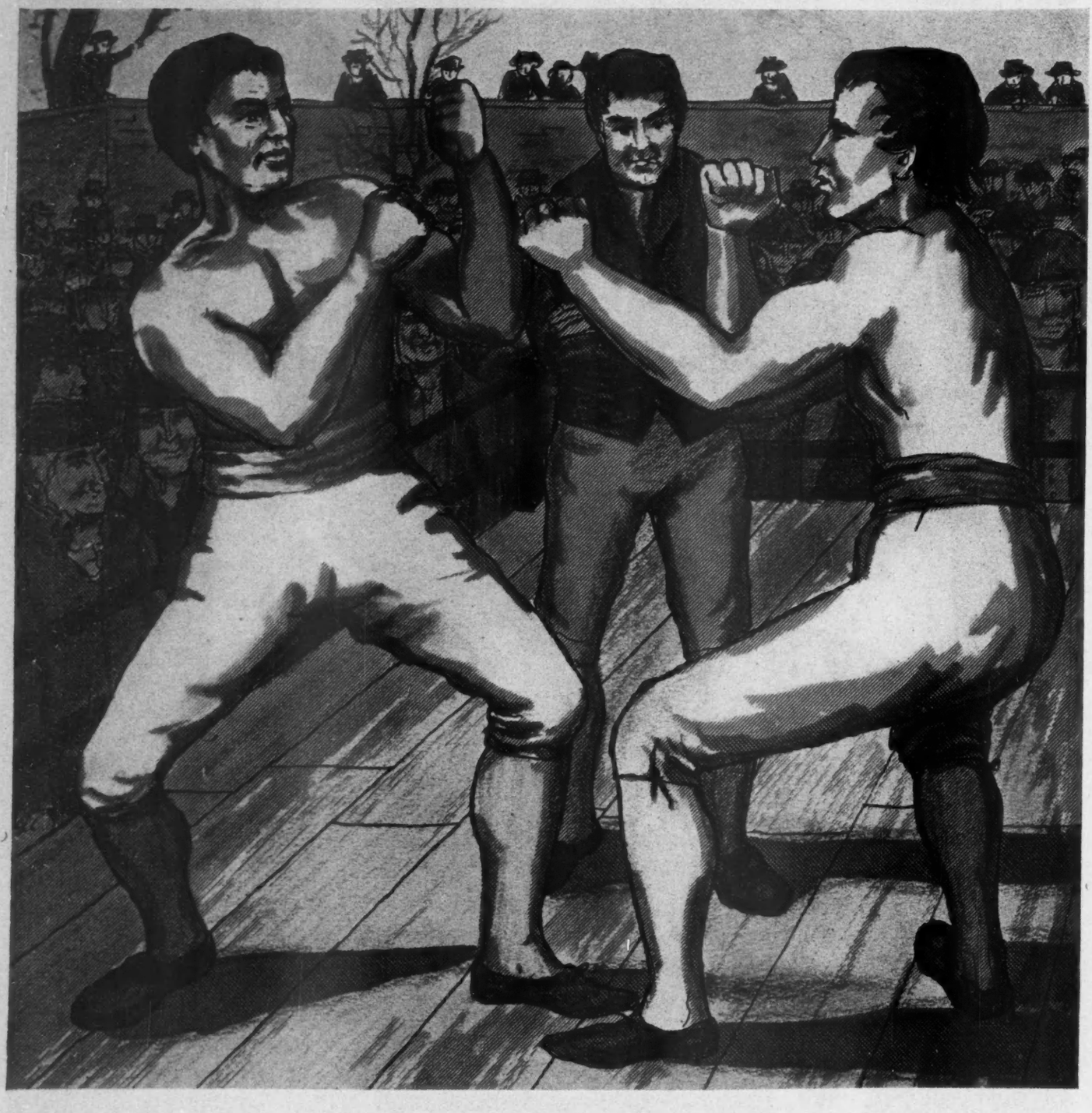

The story of the manly art goes back through the mists of time, and many a Village Green echoed the crash of bone on flesh while brawny bruisers and fine young bucks pounded their prowess in the Englishman's National Sport. Because of dreadful injuries, bare fist contests were eventually stopped by the law, and gloves or 'mufflers' were introduced, thus protecting the fighters and often preserving their very lives.

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H 3

Chemical plant

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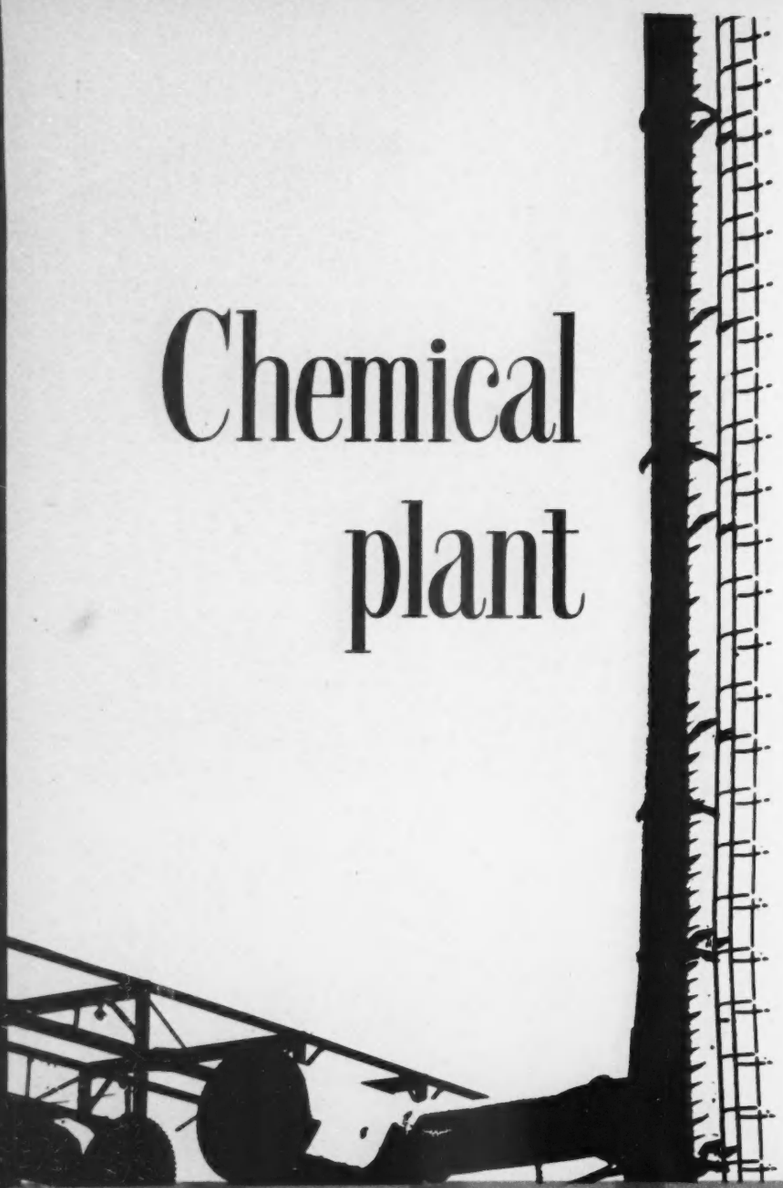
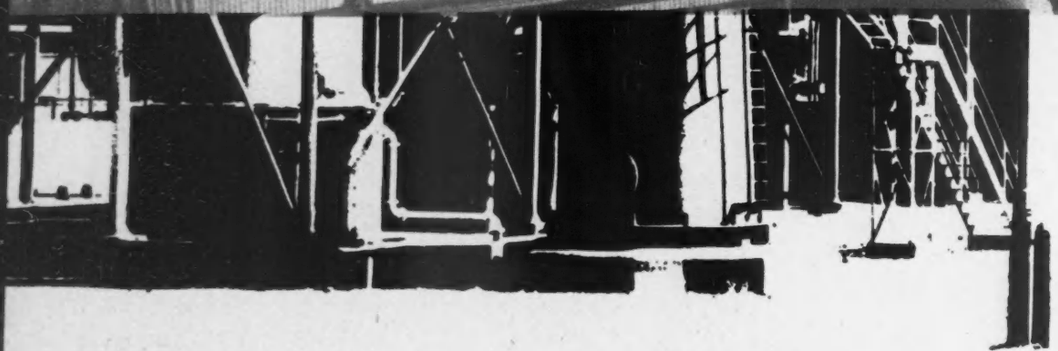




1 This general view of the electro-precipitation plant built for the United Sulphuric Acid Corporation at Widnes shows the South Battery of tail gas mist precipitators in the foreground.

2 At the Central Electricity Generating Board's Willington 'A' power station, Simon-Carves are installing four sets of these twin-flow boiler flue dust precipitators.

3 These coal dust precipitators were installed at the National Coal Board's "Phurnacite" plant at Aberaman. An efficiency of 99·93% was obtained in the official acceptance tests.

4 Type of Plant: Contact Sulphuric Acid.
Raw Material: Sulphur.
Rated Output: 175 tons per day.
Client: Laporte Titanium Limited.
Location: Stallingborough, Lincs.

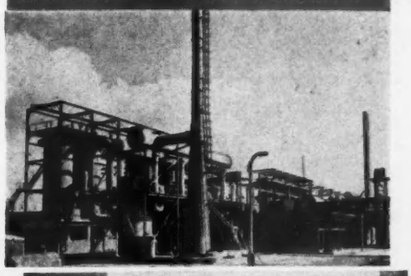
5 Type of Plant: Contact Sulphuric Acid.
Raw Material: Sulphur.
Rated output: 175 tons per day.
Client: Scottish Agricultural Industries Limited.
Location: Leith.

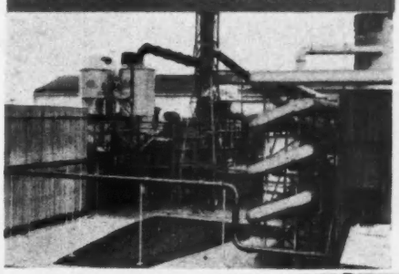
6 Type of Plant: Sulphuric Acid Concentration.
Output: 100 tons per day H_2SO_4 from 45% to 95%.
Client: British Hydrocarbon Chemicals Limited.
Location: Grangemouth.

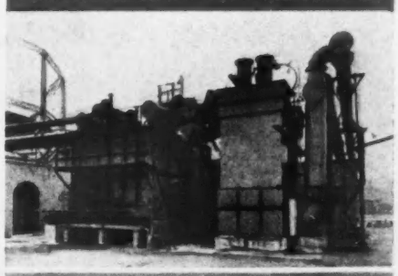
7 Type of Plant: Contact Sulphuric Acid.
Raw Material: Pyrites.
Client: African Explosives & Chemical Industries (Rhodesia) Limited.
Location: Rodia, S. Rhodesia.

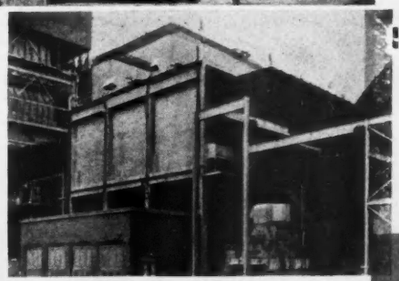
8 This two-stream gas detarring and ammonia washing plant has a capacity of 12 million cubic feet a day. It was built at the New Wortley gasworks for the North Eastern Gas Board.

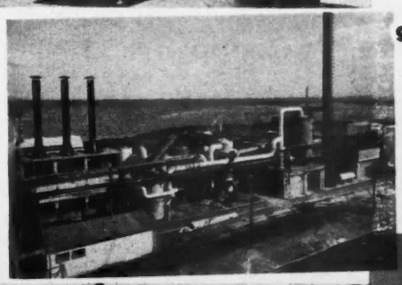
9 Built at the Stapleton Road Gas Works of the South Western Gas Board, this concentrated ammonia liquor plant has a capacity of 1,800 gallons per hour of crude liquor.

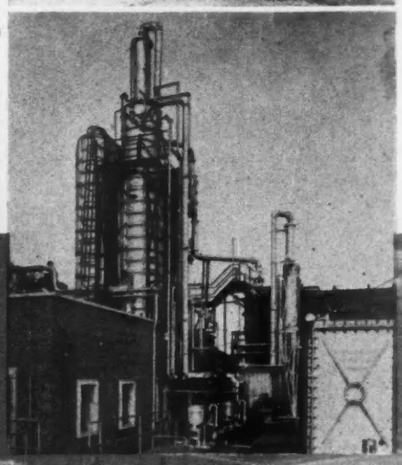


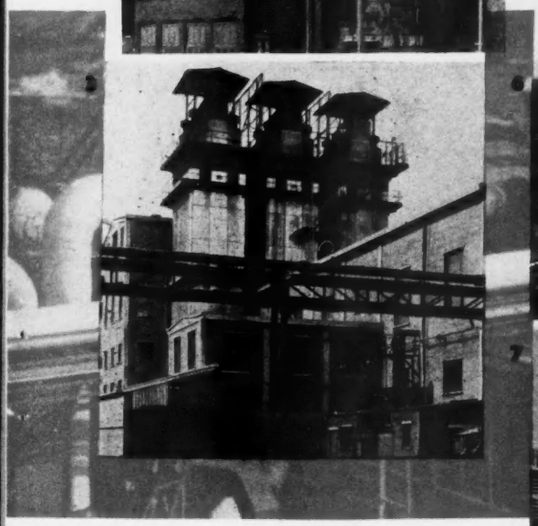


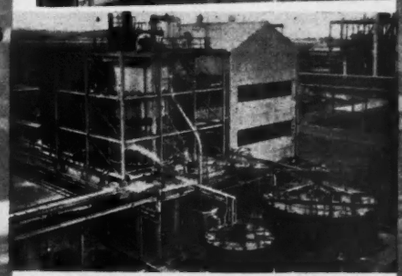


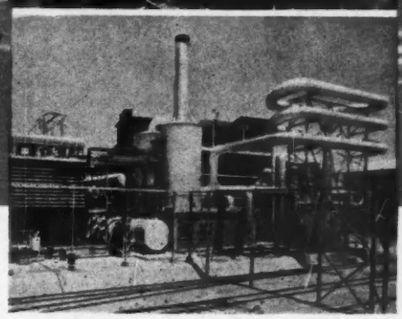


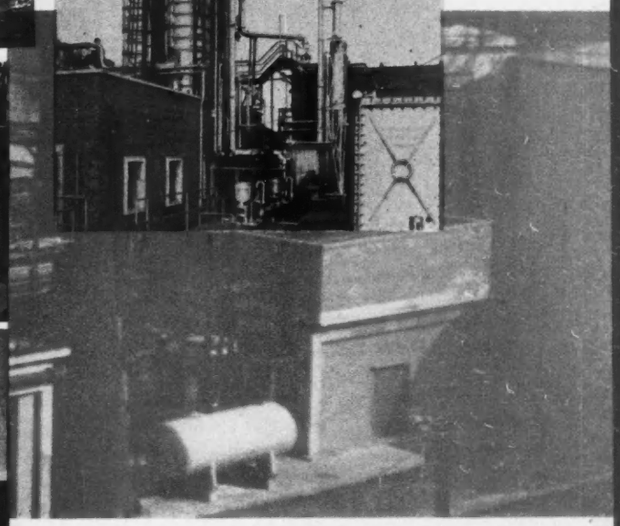












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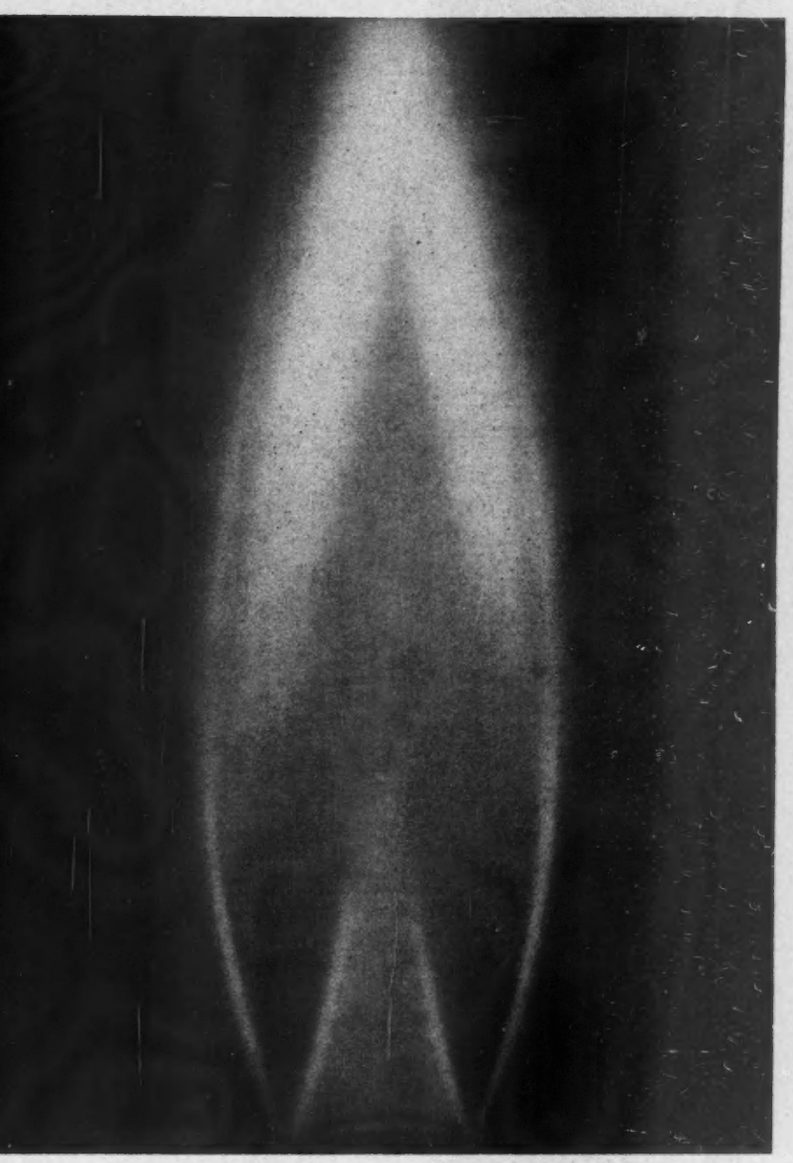

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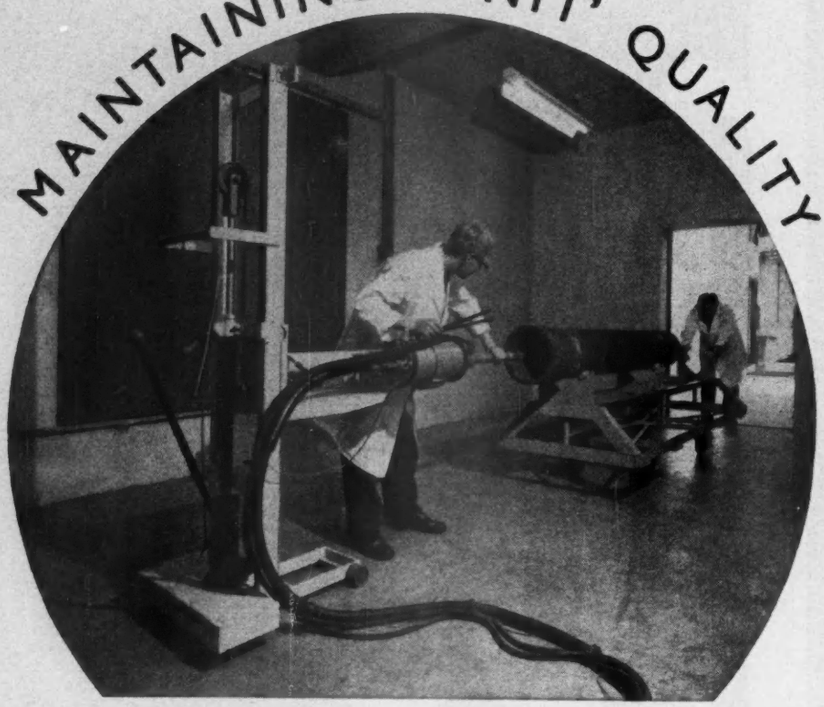

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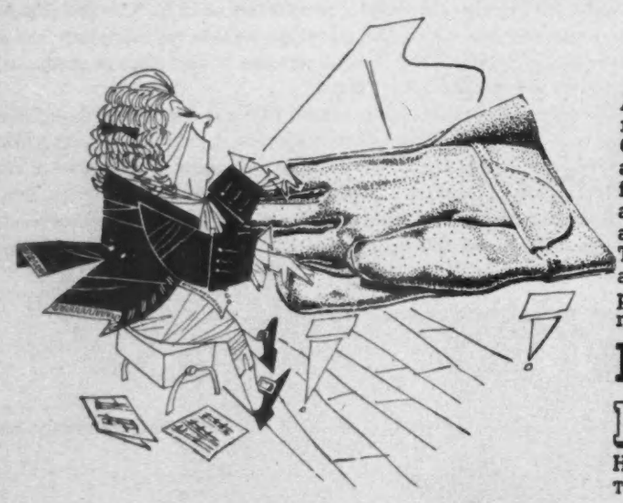

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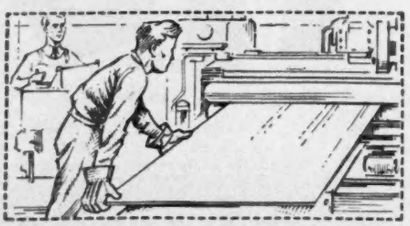

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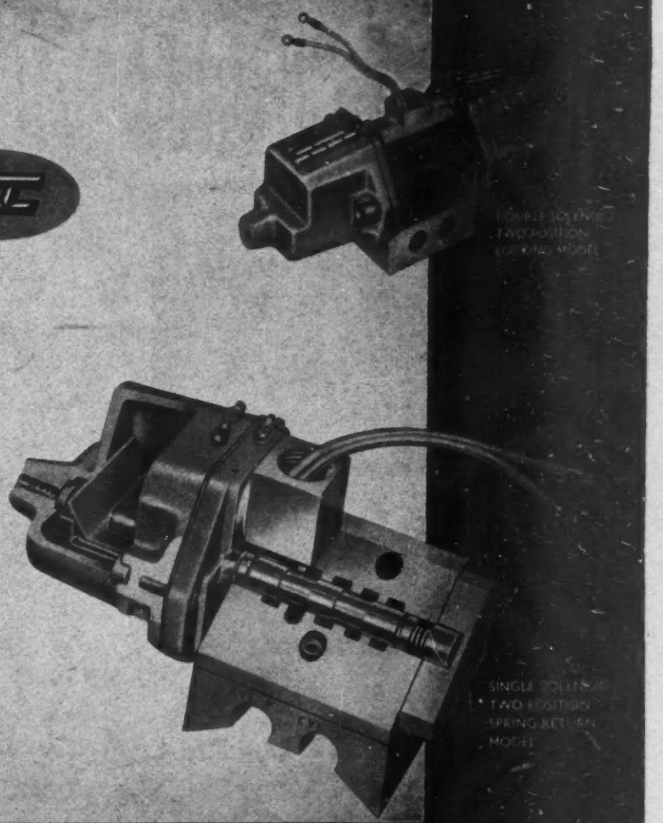

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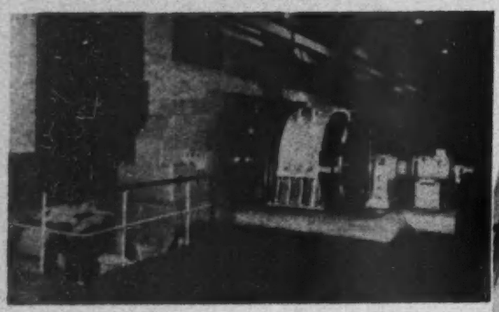
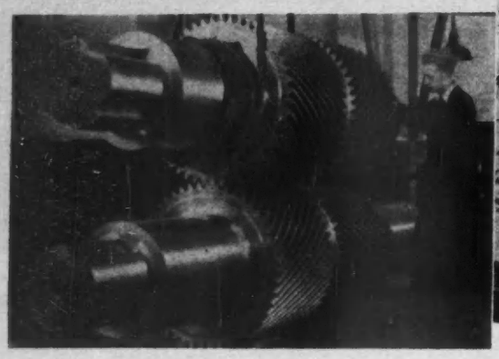


SWEDEN. A 1,500 h.p. unit driving a rolling mill in a Swedish Hot Strip Mill at Sandviken Jernwerks, A.B. Acknowledgements to W. H. A. Robertson & Co. Ltd. and English Electric Co. Ltd.



BELGIUM. A pair of large double helical pinions for an aluminium rolling mill drive. (Acknowledgements to Messrs. W. H. A. Robertson & Co. Ltd.)

YUGOSLAVIA. A 100 h.p. single-reduction unit driving a rubber mill, supplied to a rubber works at Zagreb by the Latex Engineering Company, to whom our thanks are due for this photograph.

All over Europe, our gears and gear units are playing their part in a variety of key industries, too numerous to mention here. On this page are shown just three examples selected from the many plants in Europe using equipment supplied by Turbine Gears Ltd.

From sugar-crushing to steel-rolling, from aluminium-smelting to atomic power production, industries of all types supplying many needs call for high quality gears and gear units. In this field, the name of Turbine Gears Ltd. is associated with long service and high efficiency.

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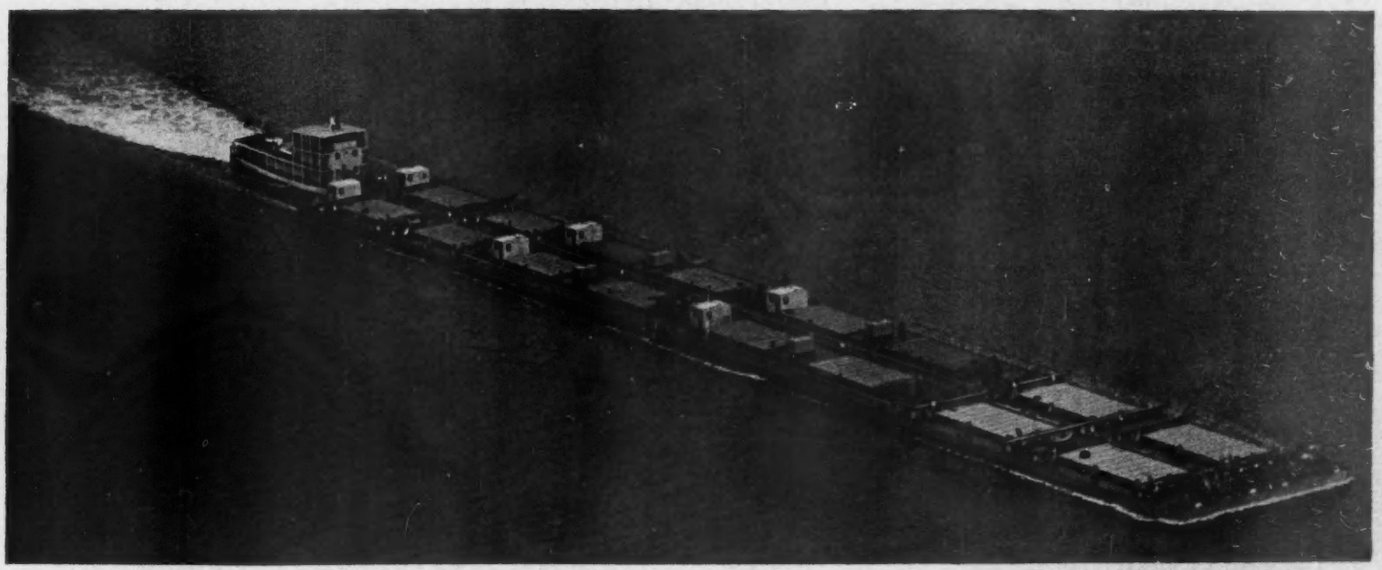

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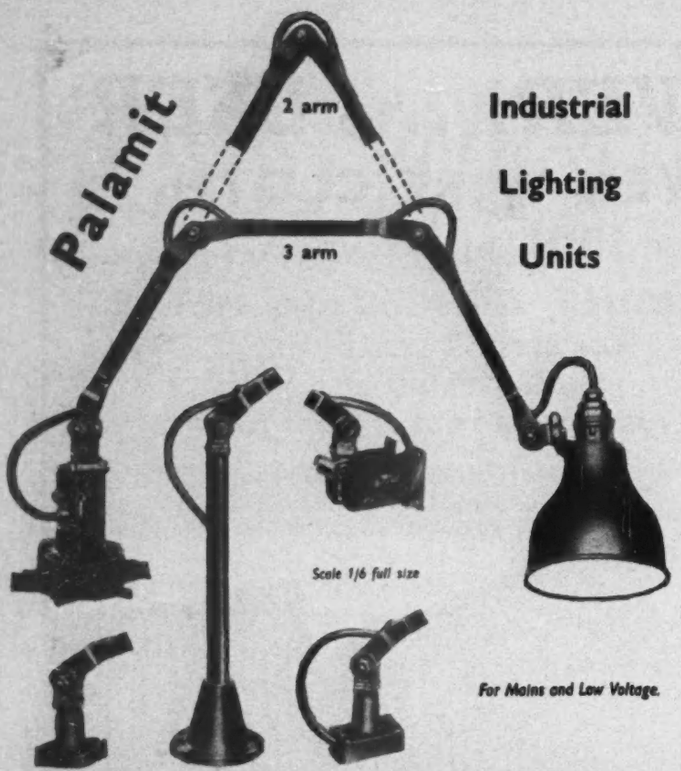

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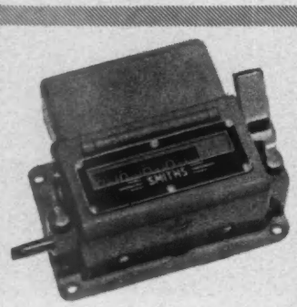

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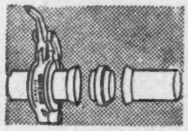
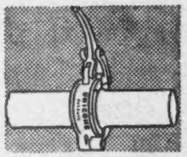
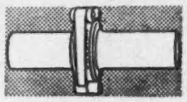

Rubber gasket in position and joint ready to pull over


Pipe ends joined ready for locking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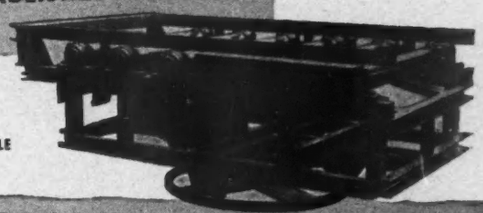
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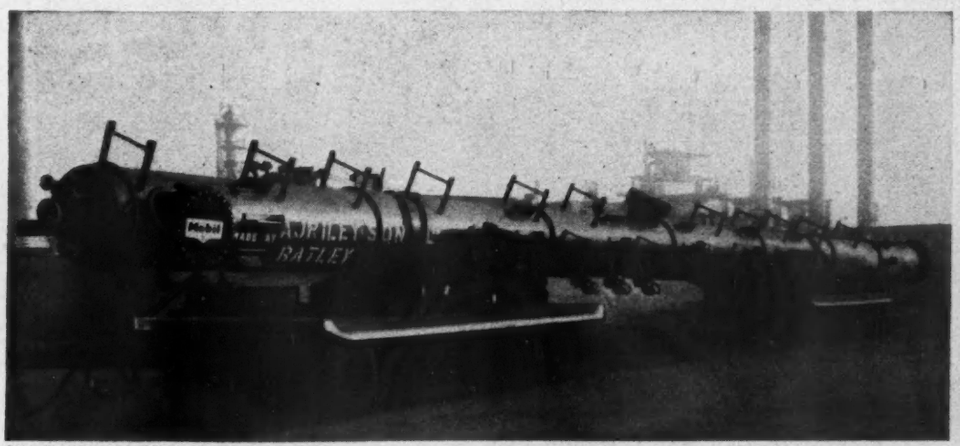
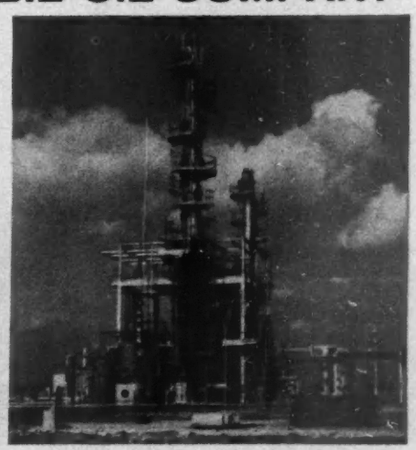


ONE OF THE COLUMNS ARRIVING ON SITE



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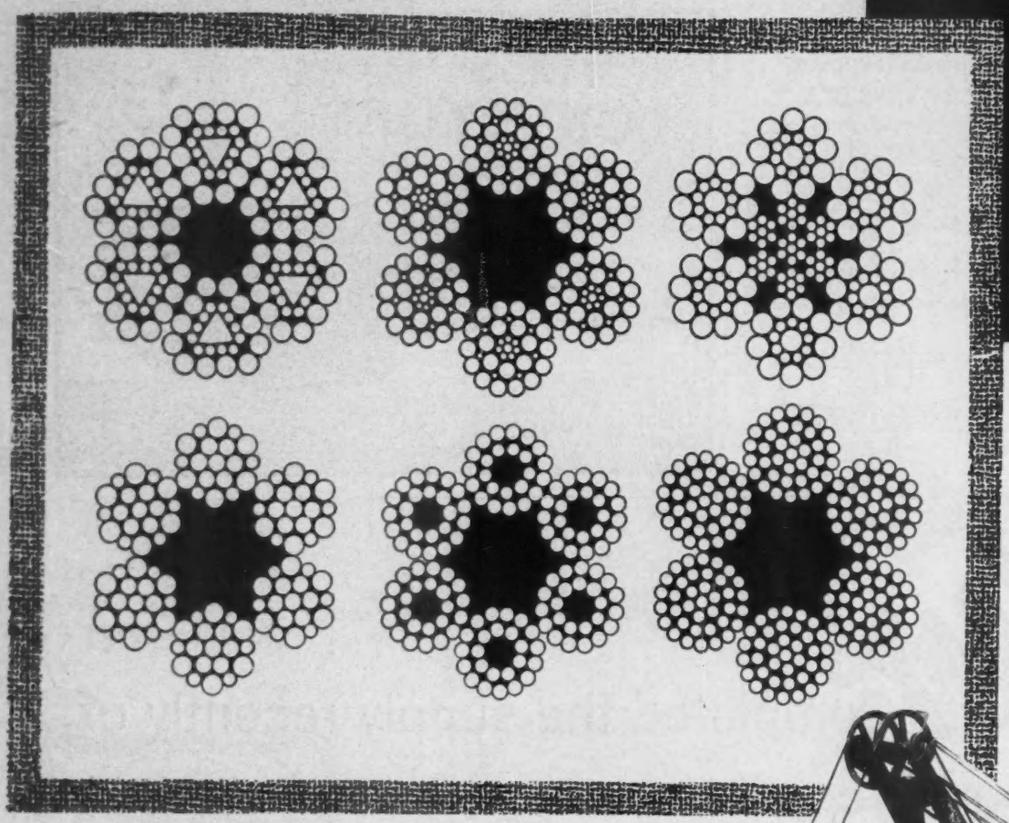

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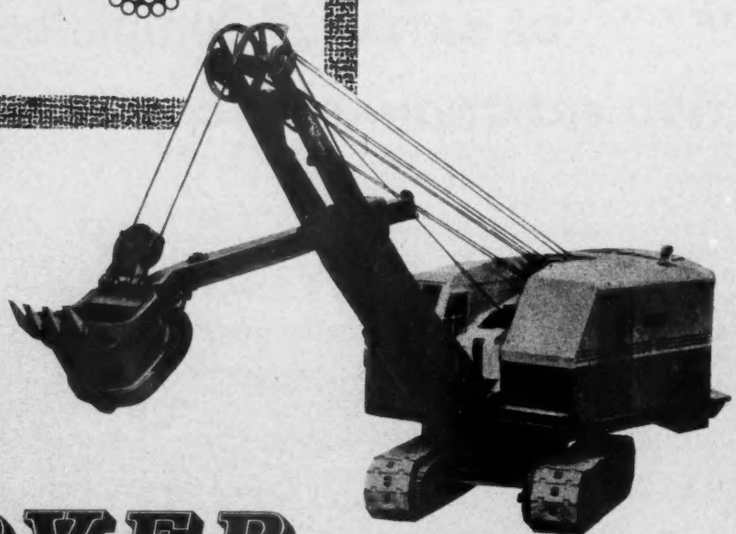

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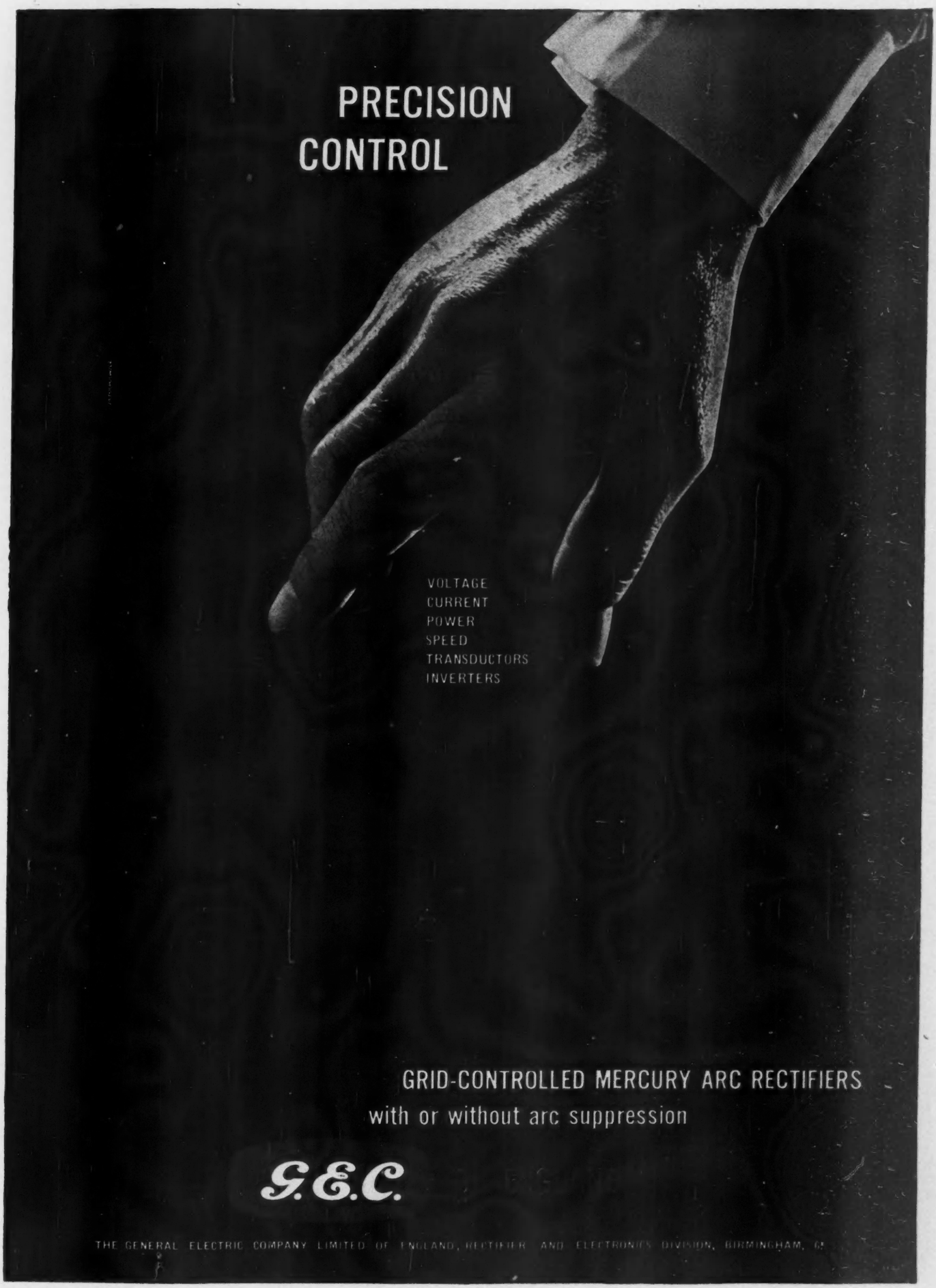
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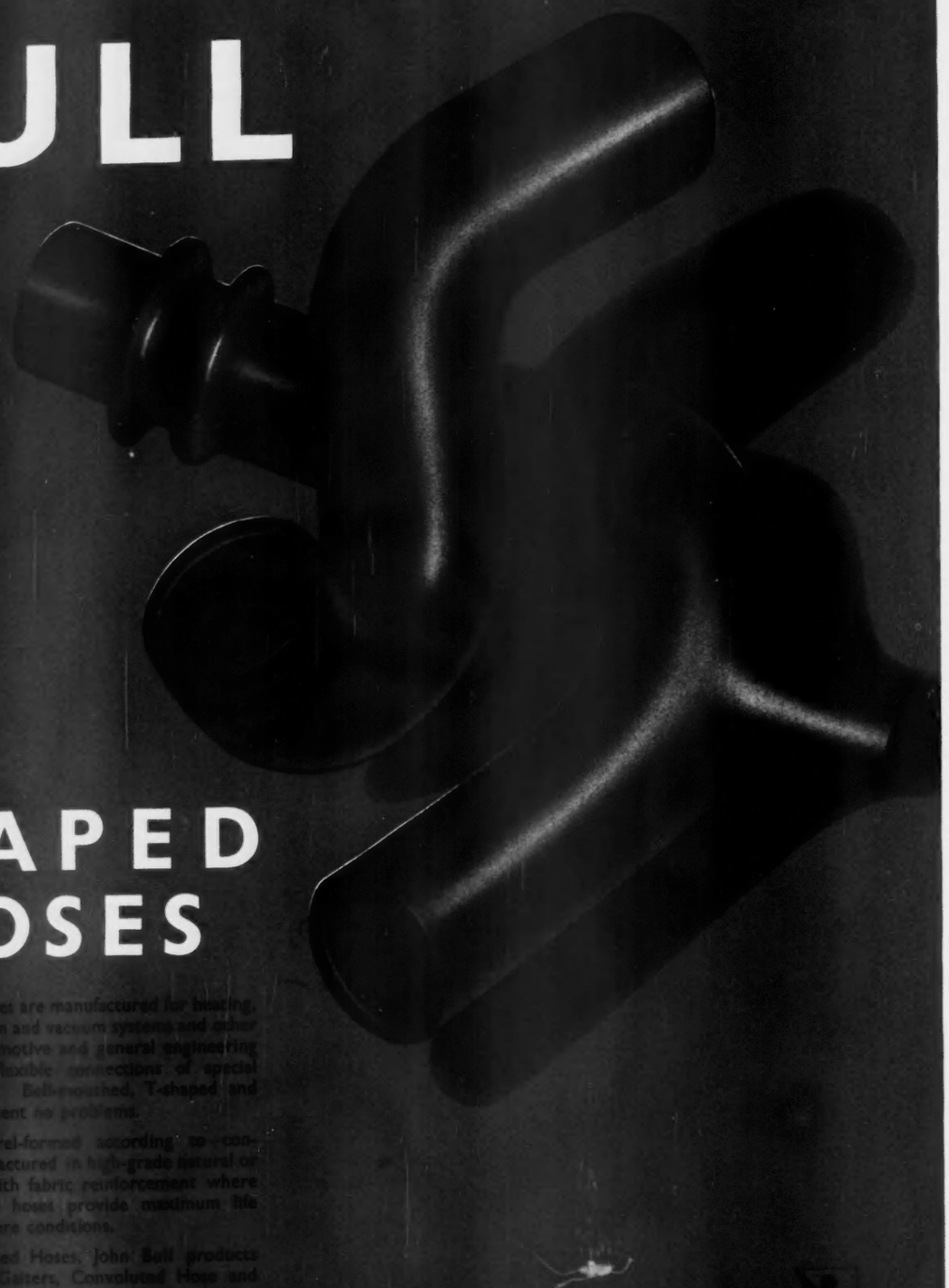

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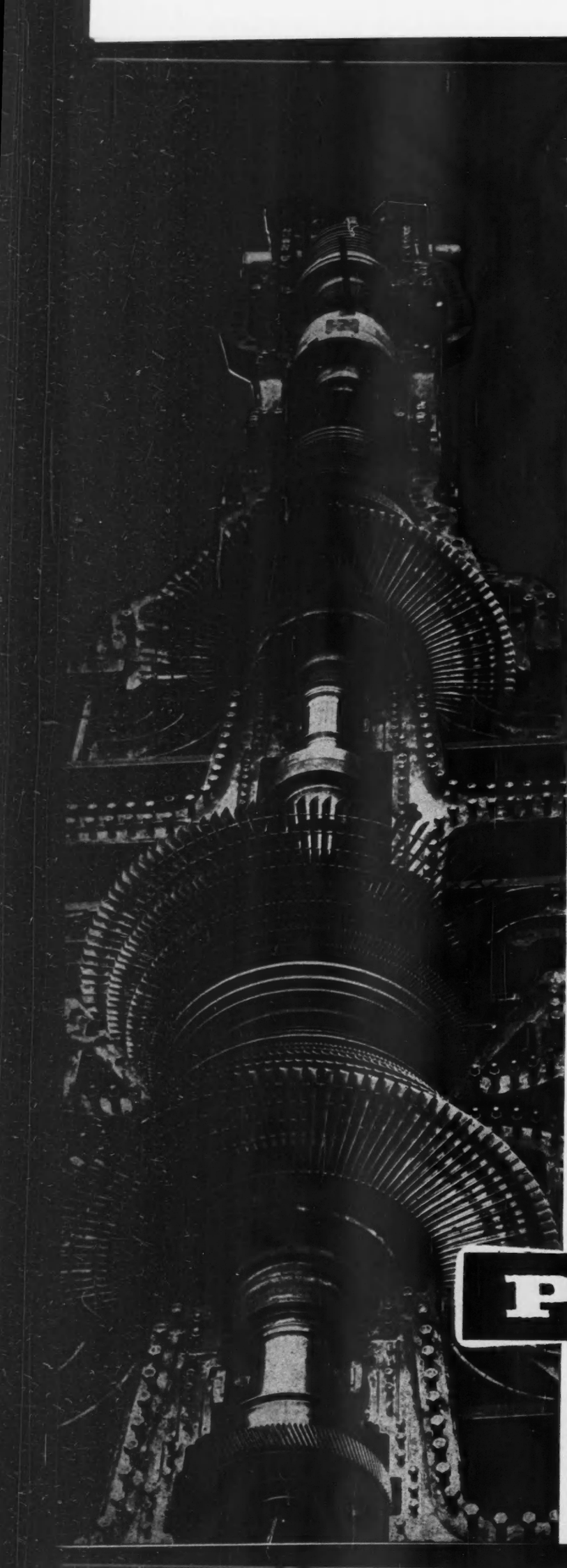

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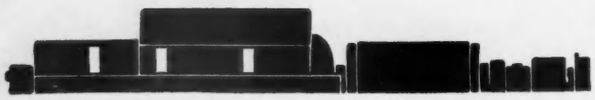

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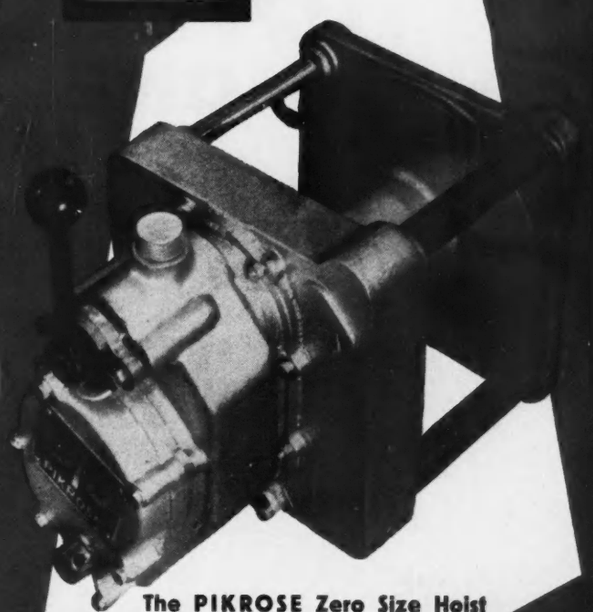

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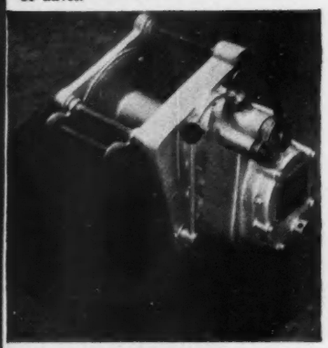

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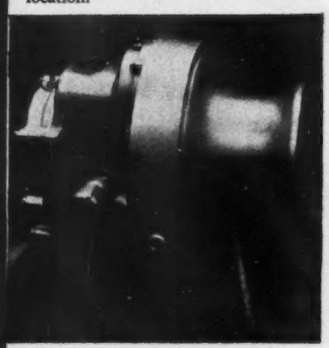

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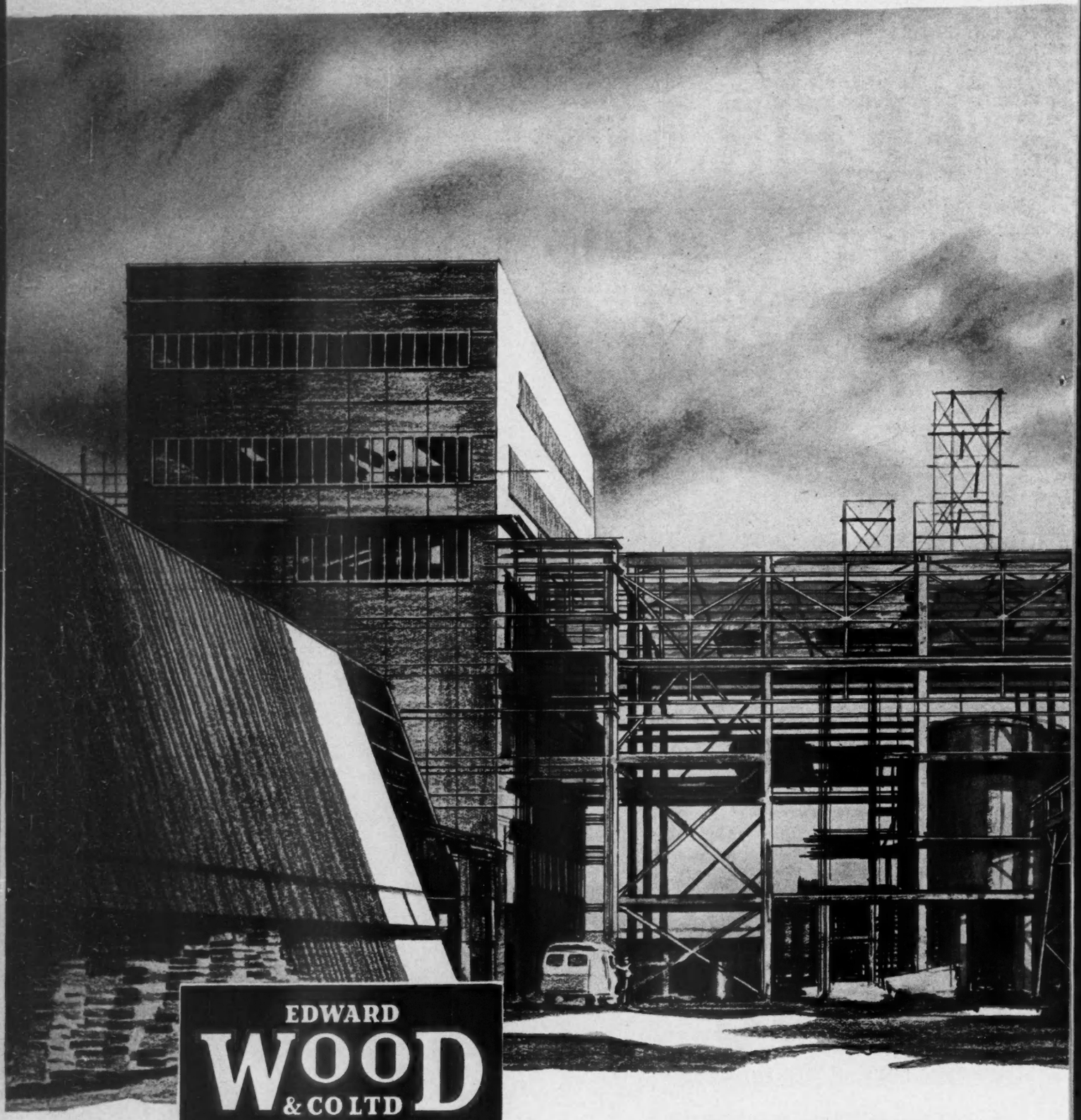

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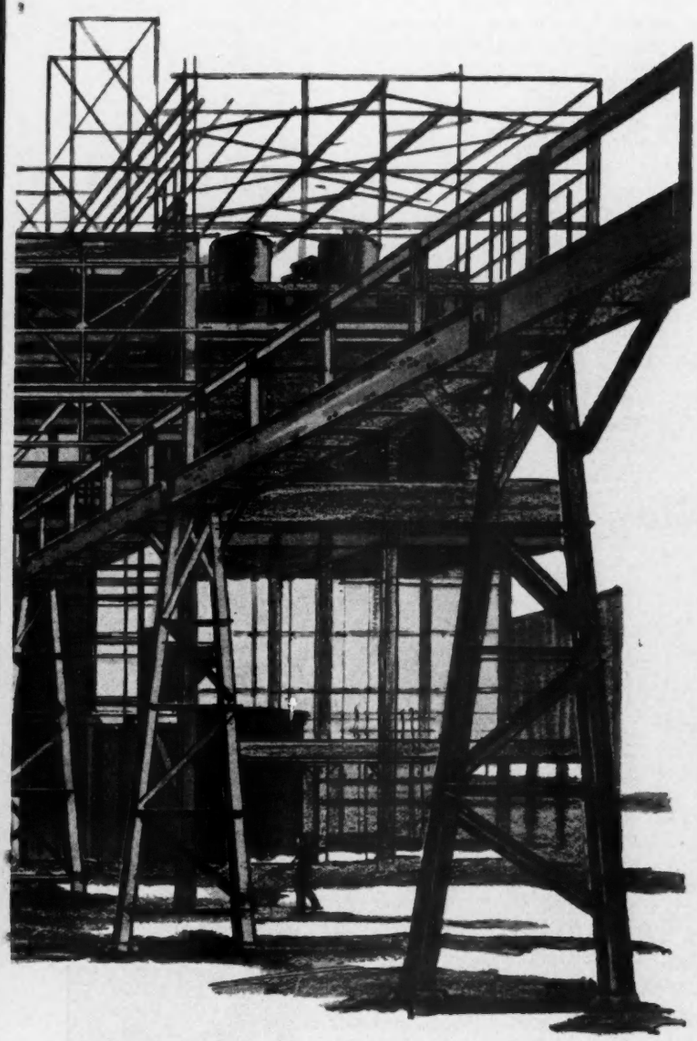
for Titanium Pigments



Construction of these extensions at the Grimsby factory of British Titan Products Co. Ltd., called for particular understanding of the requirements for the production of Titanium Pigment. The project is indicative of the scope of steelwork construction, and of the many engineering problems encountered and overcome.

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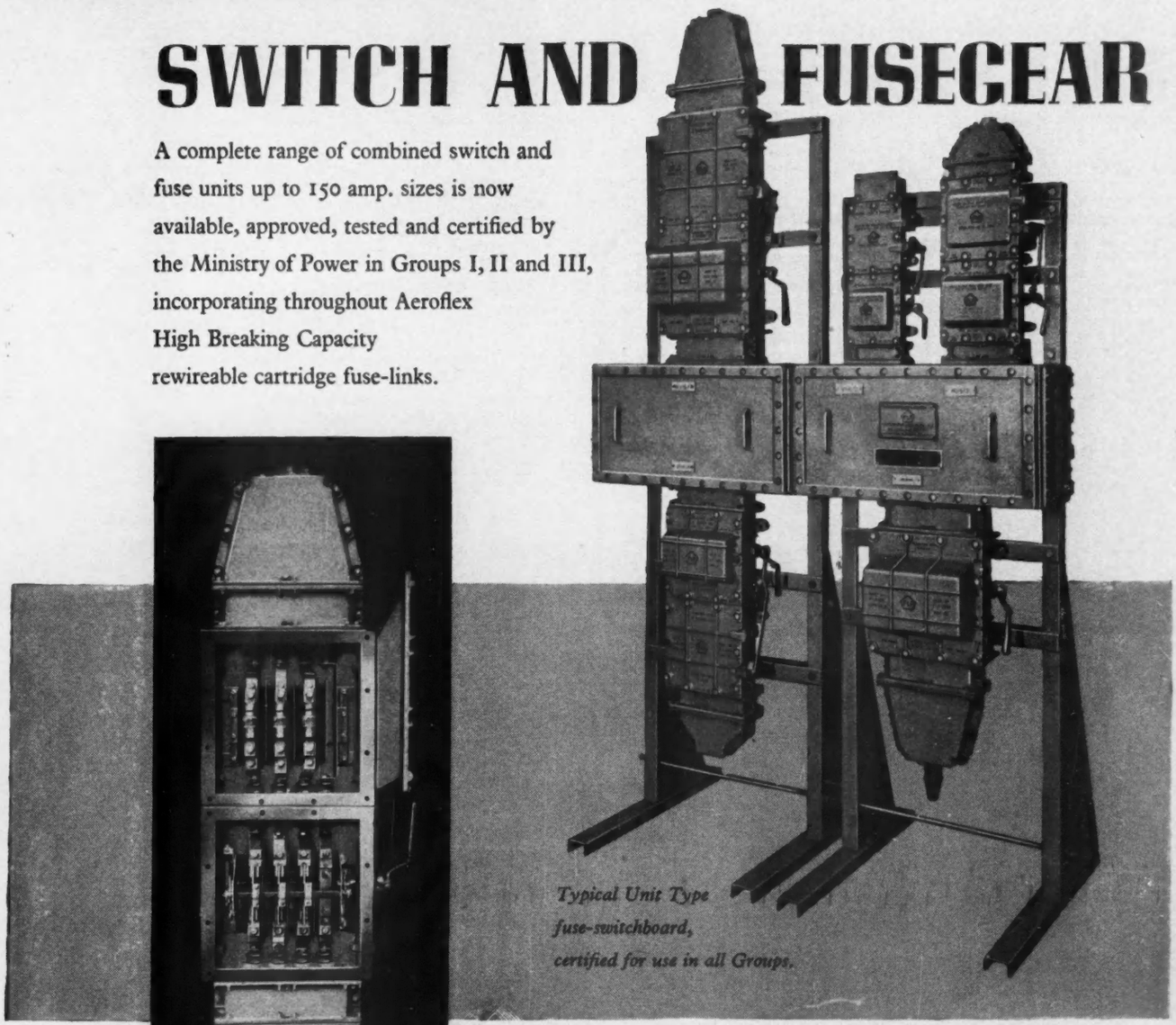
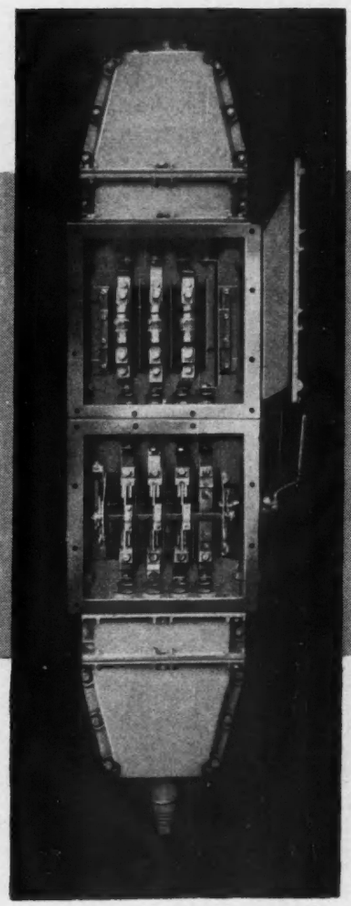


Typical Unit Type fuse-switchboard, certified for use in all Groups.



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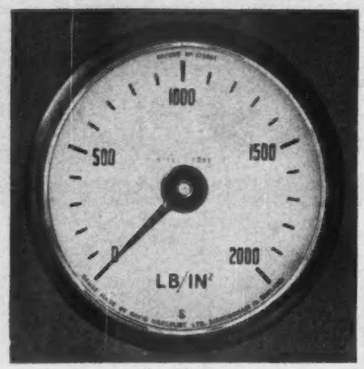

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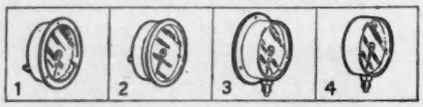

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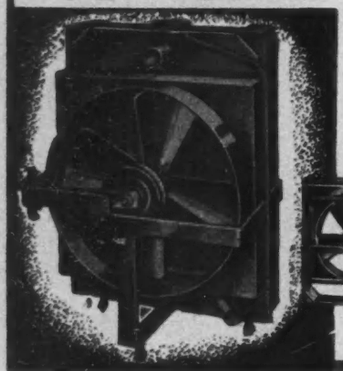

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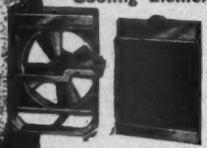

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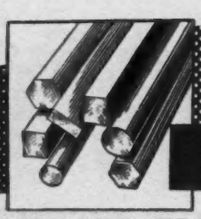

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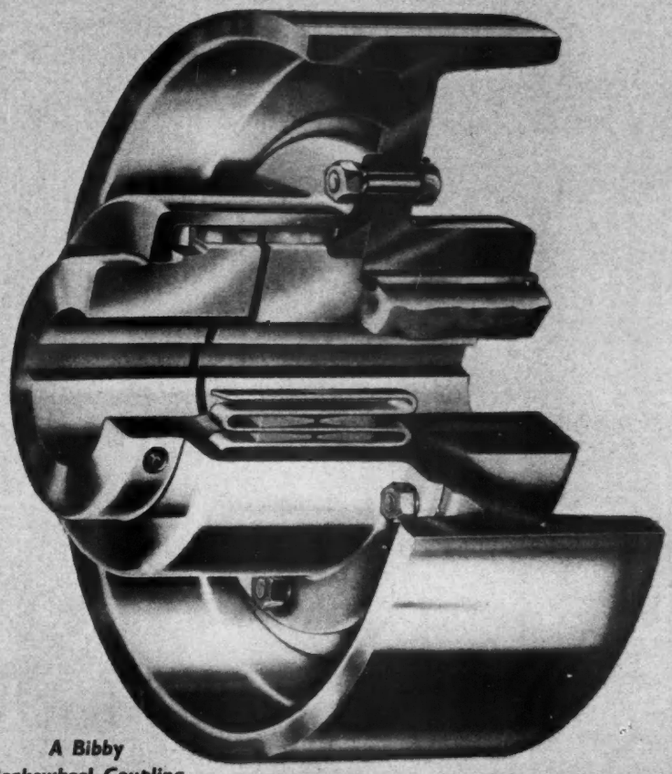

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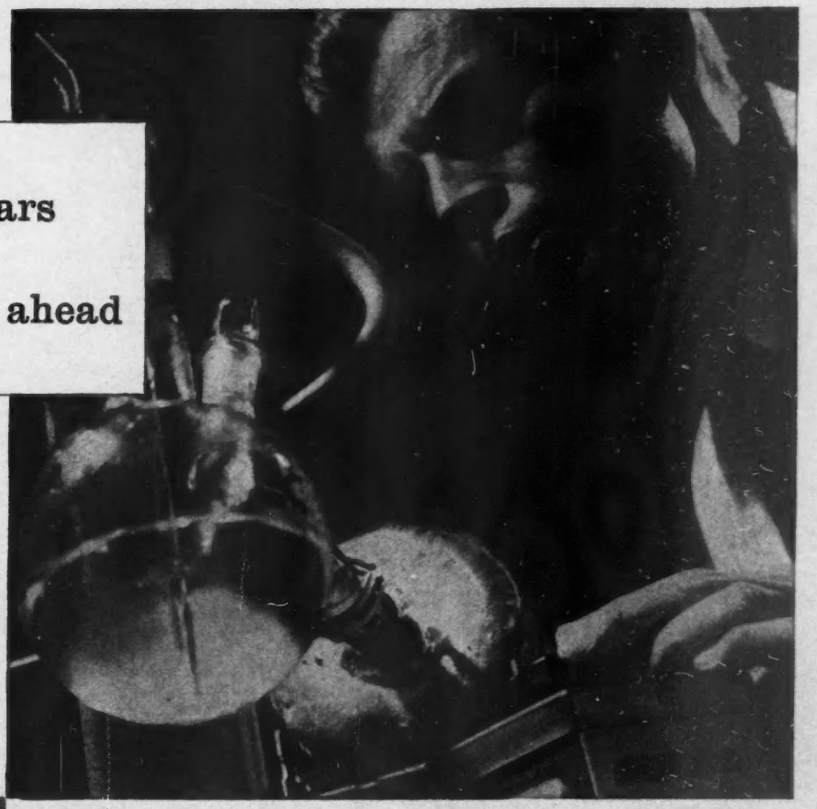

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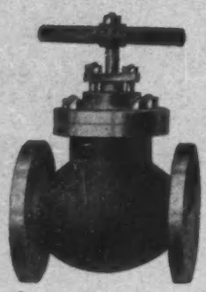

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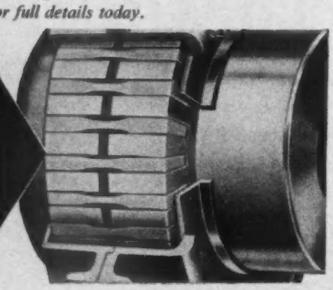

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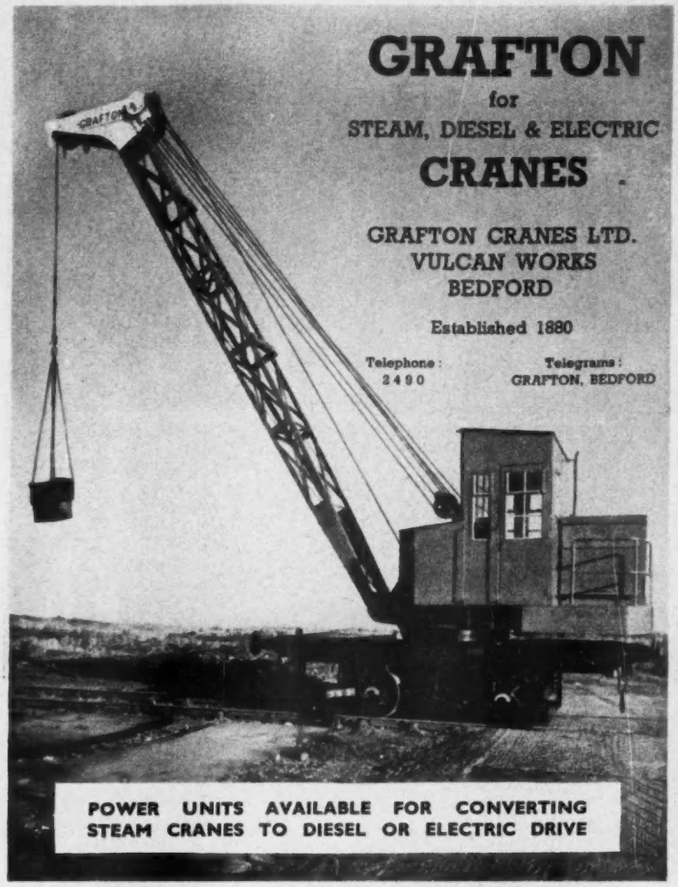

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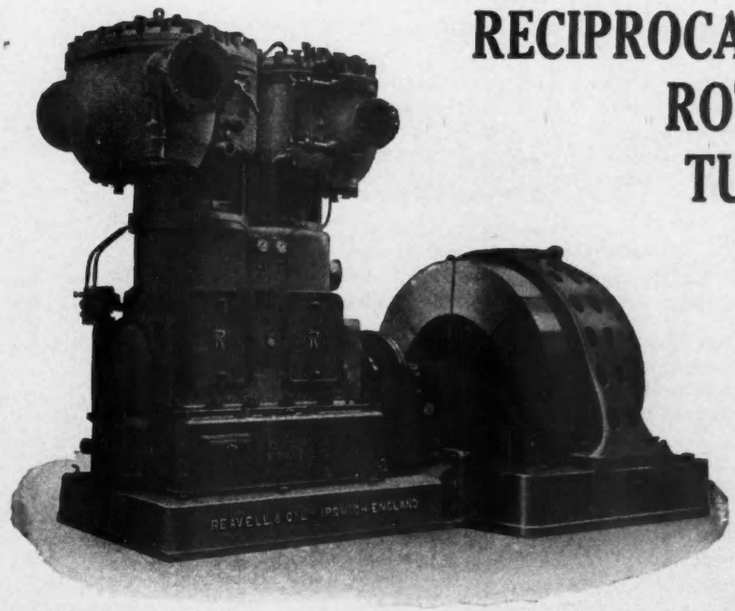

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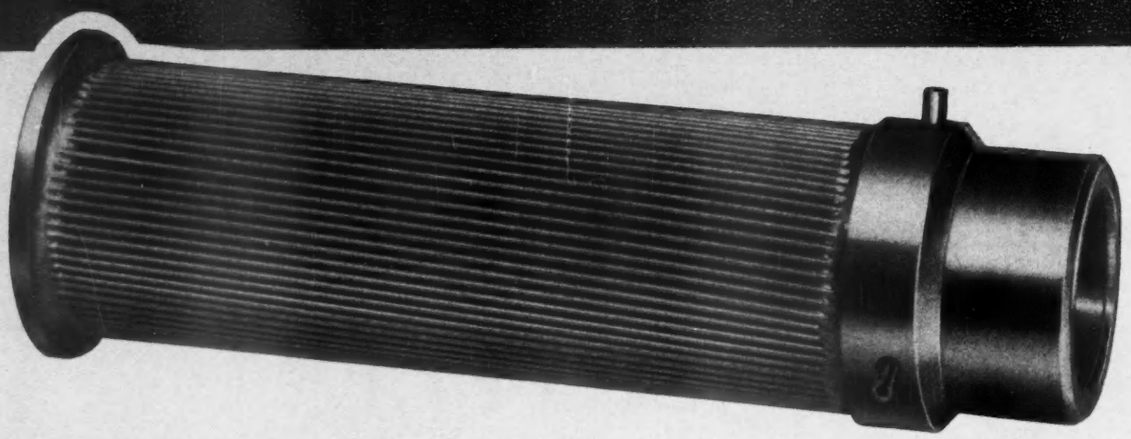

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POROLOY T.

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The illustration (above right) shows the many sizes and forms—seamless tubes, flat discs, corrugated elements etc.—in which Poroloy can be manufactured.

Both filter elements are manufactured in conditions of micro-cleanliness and before despatch are individually checked for performance in the bubble point testing equipment (right).

Poroloy was developed by the California Institute of Technology and is manufactured in the U.K. under license from the Bendix Aviation Corporation, U.S.A.

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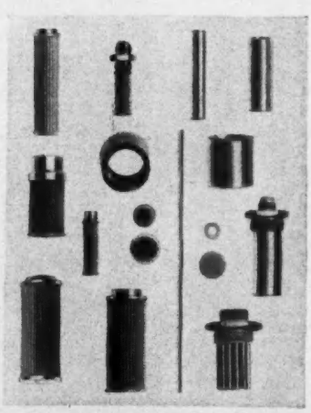

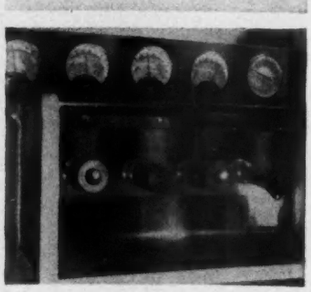

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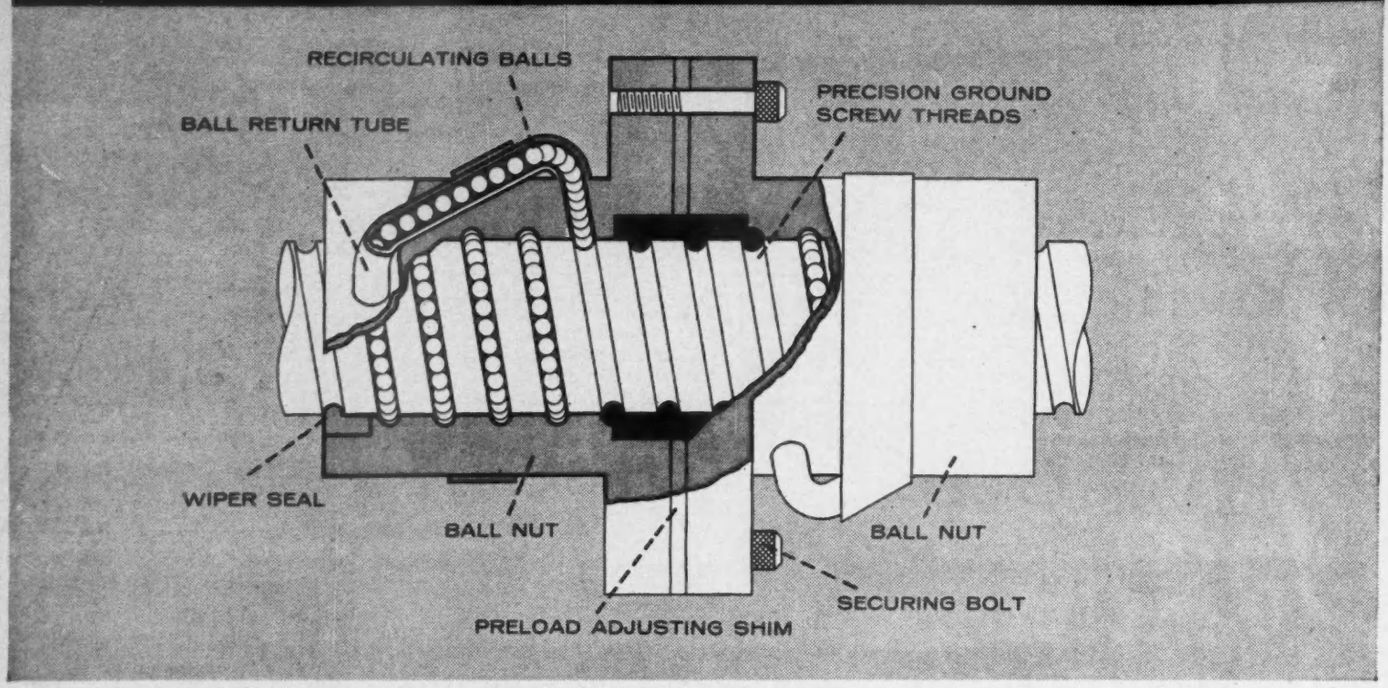

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Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

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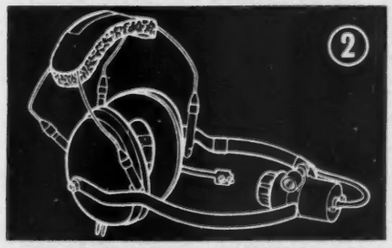
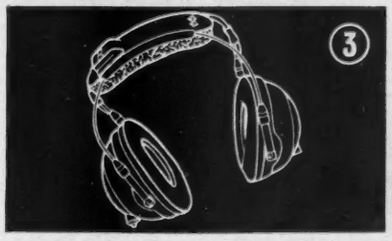
(A) P.V.C. Seal Cushion filled with non-freeze liquid. (B) Shells moulded from high impact glass filled plastic. (C) Inner pad of polyurethane sponge.





Three models illustrated: (1) standard "EARGARD"; (2) for two-way intercommunication with visor type noise cancelling microphone or with hand held noise cancelling microphone; (3) Eargard fitted with transistorised magnetic Induction Loop Receiver.

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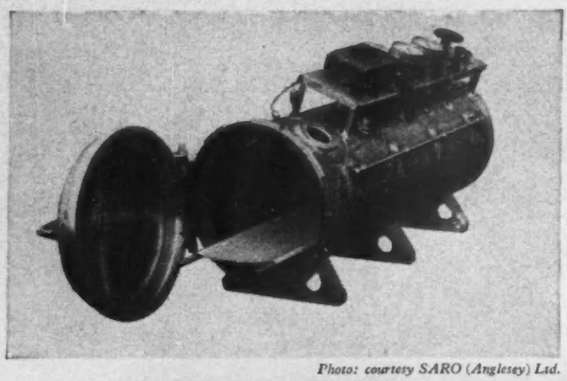

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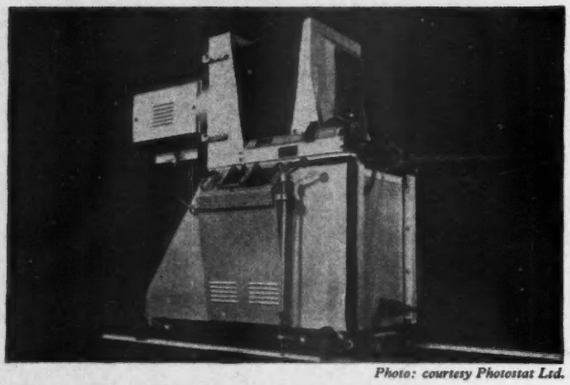

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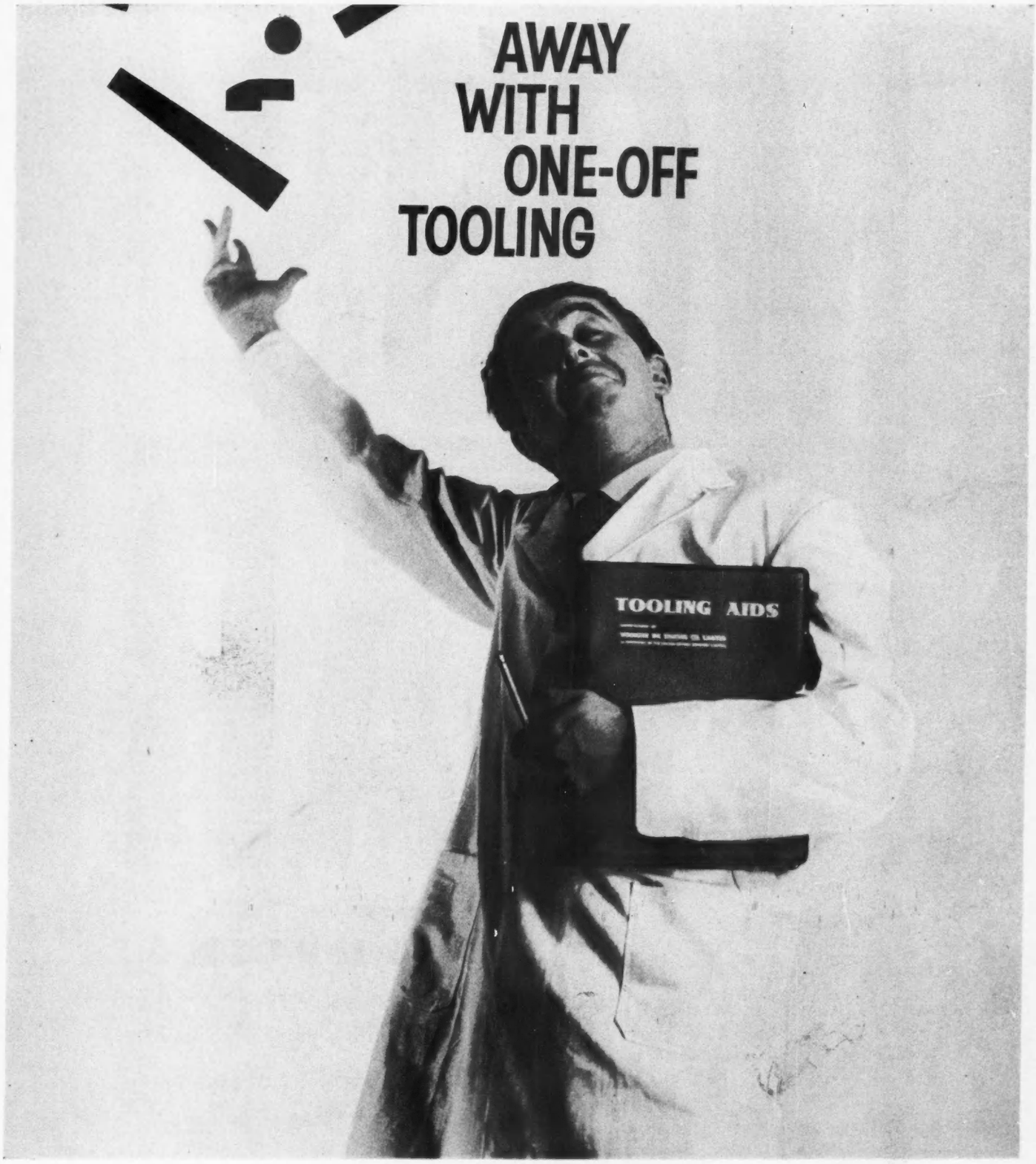

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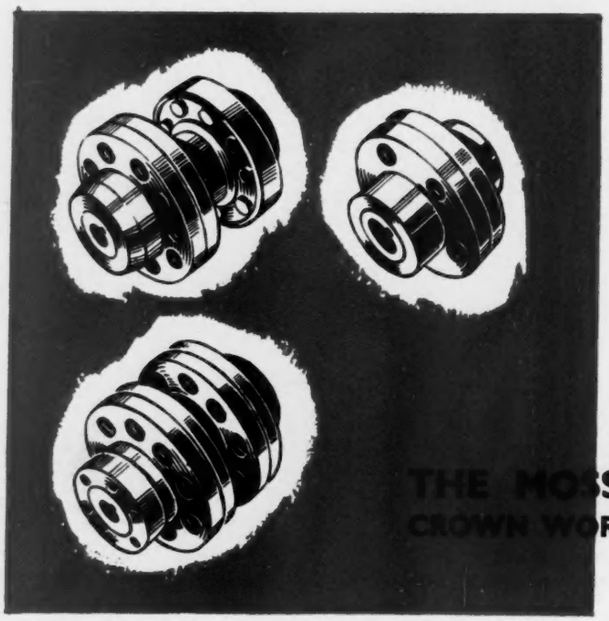

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